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A 600 H. P. Motor-Driven Ferry Boat

By CHAS. J. BELDEN

IN the world of marine engineering and ship building today, nothing looms up larger than the broadening possibilities of the internal combustion engine. Whether the type be hot bulb, Diesel, or electric ignition, the successful application of the so-called "gas engine" to the propulsion of every conceivable kind of craft has long since been an undisputed fact. It is probably a little known fact that the first marine gas engine ever built in the world was installed and operated on the Pacific Coast in 1884 by a man named Morse Barret. Most authorities have erroneously credited this honor to Daimler, but Barret's engine has been shown to have antedated the European motor by several years.

It is well known that the development of the larger marine motors have, as a rule, been along the lines of the hot bulb and Diesel types, for the practical limit of a heavy duty engine for commercial use was generally thought to be in the neighborhood of three hundred horsepower. A notable exception to this rule is to be found in the ferry boat "Ramon," which has been in operation for three years as a connecting link in the Oakland, Antioch & Eastern Railroad. This line is operated from San Francisco into the rich farming lands of the Sacramento Valley. In the construction of the road over the low-lying country at the mouth of the San Joaquin River, a large amount of bridging and trestle work was necessary. At one point a very wide expanse of water was encountered and as the cost of a bridge would have been prohibitive, it was decided to ferry the trains across by means of a boat.

When the construction of a suitable vessel was first considered, three prime factors were used as a basis, namely: time of delivery, reliability, and economy of operation. The design of the hull was influenced to a large extent by the first factor, and as a result standard marine practice was sacrificed in order to utilize as far as possible, materials which would be most readily obtained. Reliability of operation is of course a prime requisite in any marine installation, but it was of peculiar importance in this case, due to the fact that the boat was to act as a connecting link in the main line of the railroad and a breakdown of even short duration would upset the schedules of the entire system. The intermittent character of the service of the boat demanded a power plant requiring a minimum number of men for operating it and the elimination of any fuel consumption between trips.

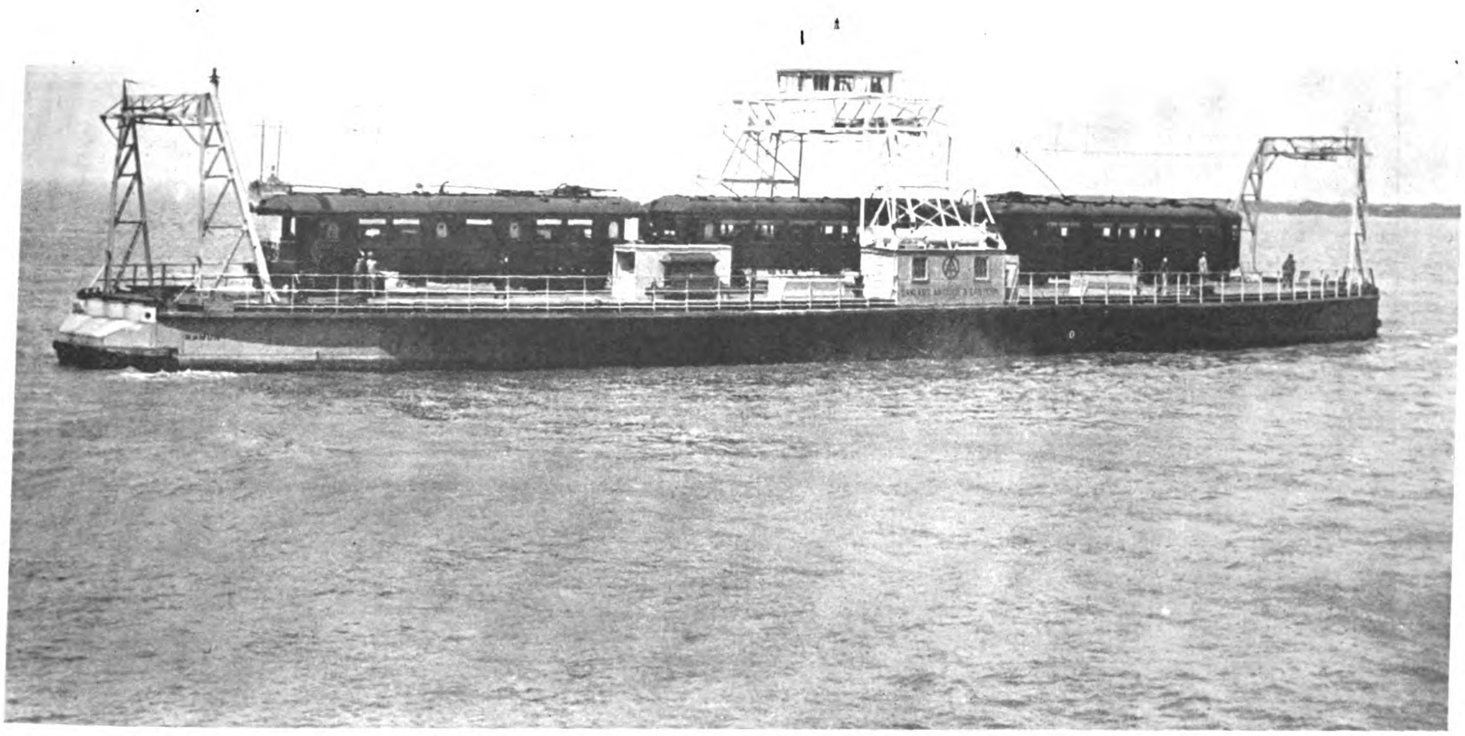
The principal dimensions of the "Ramon" are as follows:

Over all length	236	feet
Beam	58	feet
Maximum draft	12¼	feet

The design of the hull is boxlike in appearance and possesses several unusual features. Flat plates are used throughout, for it was thought that the elimination of curves would greatly expedite construction. The ends were made very flat in order to present a large displacement and thus reduce tipping when loading or unloading cars. Two watertight bulkheads extend the entire length of the boat and form a central girder which gives the hull extreme longitudinal stiffness. Two transverse bulkheads placed across either end of the engine room give transverse rigidity, and at the same time divide the hull into eleven watertight compartments. The box-like hull, although rather clumsy in appearance, has been found most satisfactory in this service, and under an uneven load but a very slight list is noticeable. With four freight cars aggregating 350,000 pounds on one side, a maximum deflection of only four degrees is recorded.

The pilot house is located amidships on a steel bridge supported over the tracks. At the base of the steel bridge towers are deck houses which contain toilets, lamp room, and cabin. Below decks are found the galley, dining room and crew's quarters.

There are three tracks on deck, each two hundred and twenty feet long. A total of nine passenger coaches can be carried at one time. The

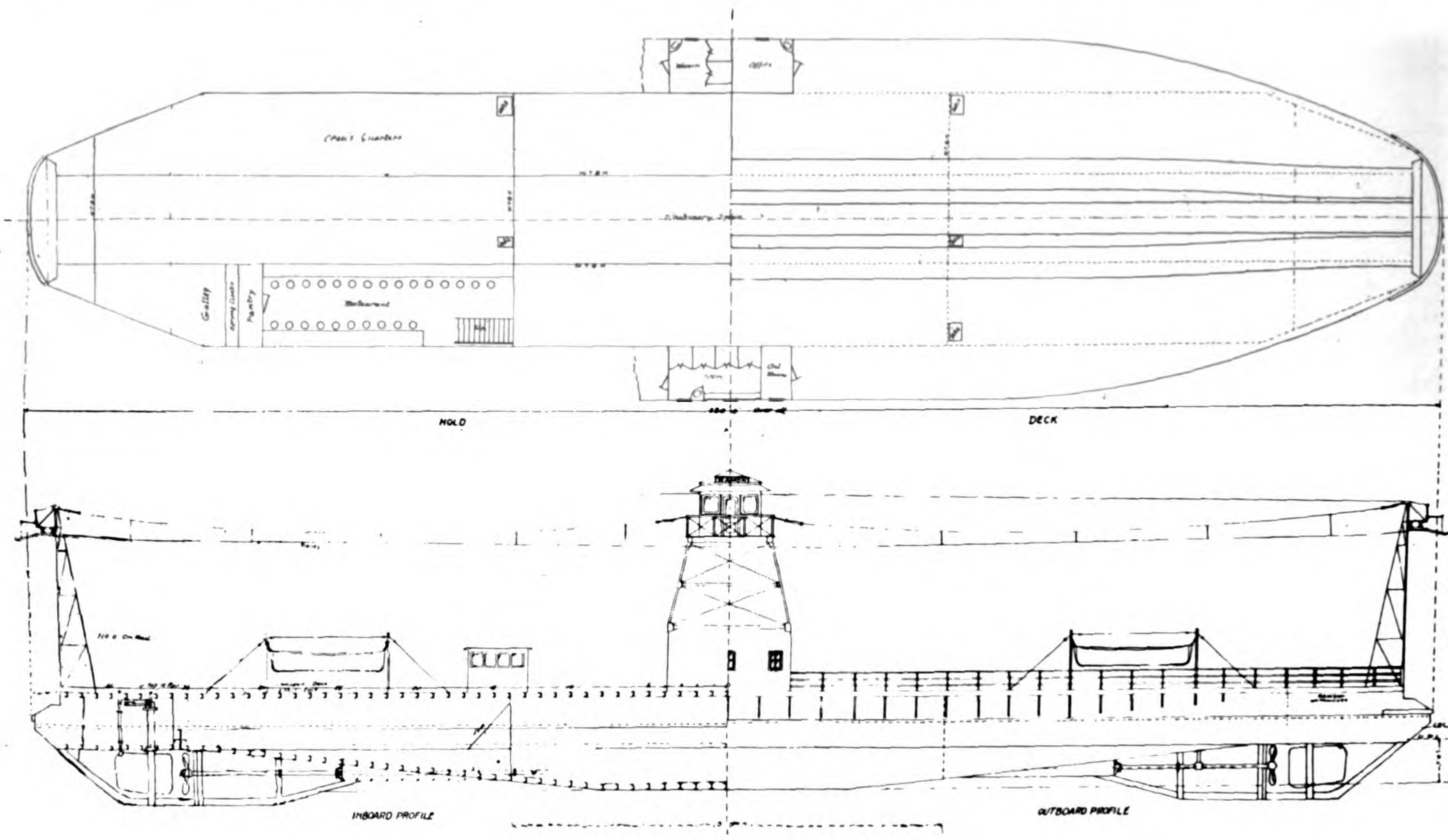


MOTOR-DRIVEN FERRY-BOAT "RAMON"

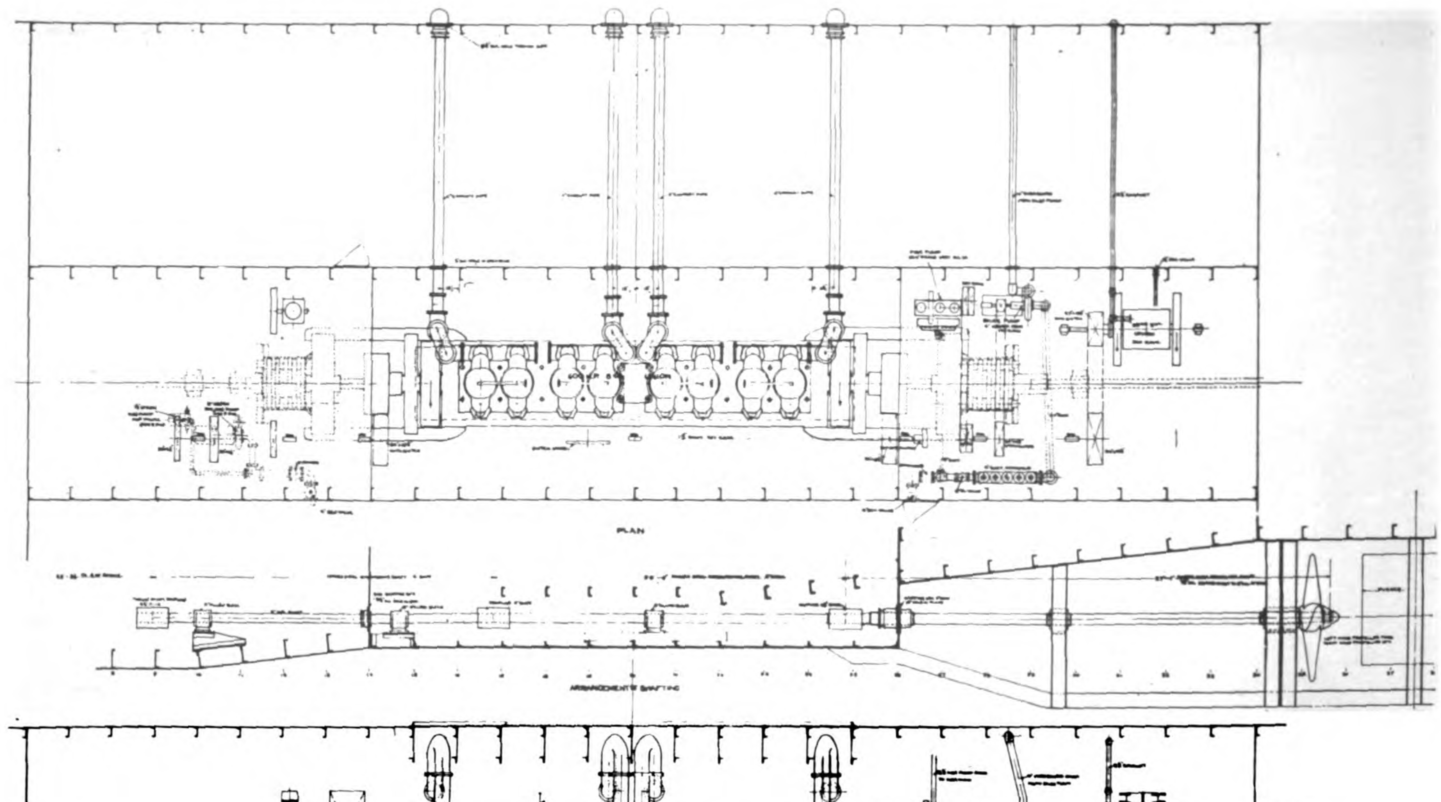
rails are bolted to the steel deck plates, but a wooden surfacing laid flush with the top of the rails provides a safe and comfortable promenade for the passengers while the boat is in transit. Two steel towers at either end of deck support the 1,200-volt trolley wires which are connected to the wires at the landing stage through switches operated from the pilot house. Steering is accomplished by means of balanced rudders six by nine feet placed very close to the propellers and controlled by a pneumatic gear.

Not the least interesting and unusual feature of "Ramon" is to be found in the propelling machinery. The main engine is an eight-cylinder 600-horsepower unit manufactured by the Union Gas Engine Company of Oakland, Cal., and is probably the largest marine motor of the electric ignition type ever constructed. The engine weighs approximately one hundred and twenty thousand pounds and measures forty-six feet long over the thrust blocks. The normal speed is 210 r. p. m. The cylinders are cast separately and are of a design called the "open crosshead type," well known to users of the larger marine motors on the Pacific Coast. The unusual length of the cylinder permits of the lower being cut away to form a crosshead guide. The piston is also exceptionally long and has a port to correspond to the opening in the cylinder extension. The wrist pin, which is located below the port in the piston, is kept cool by the circulation of air induced by the pumping action of the piston. In this way both the upper connecting rod brass and the piston head are effectively cooled without resorting to the use of water circulation and its consequent complications.

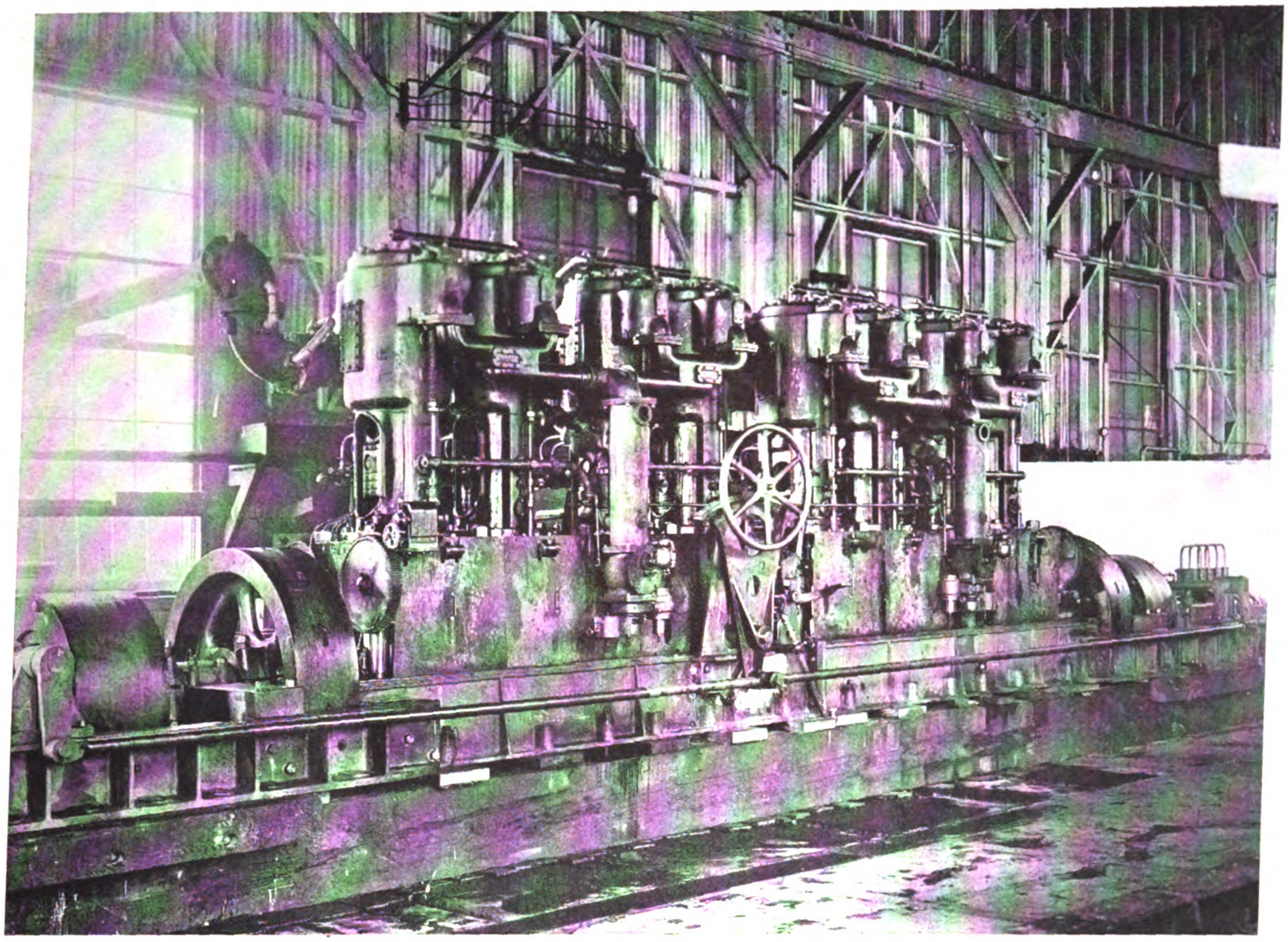
The inlet and exhaust valves are disposed on either side of the cylinder in the familiar "T" head arrangement. The exhaust valves are water



DECK PLAN AND PROFILE OF "RAMON"



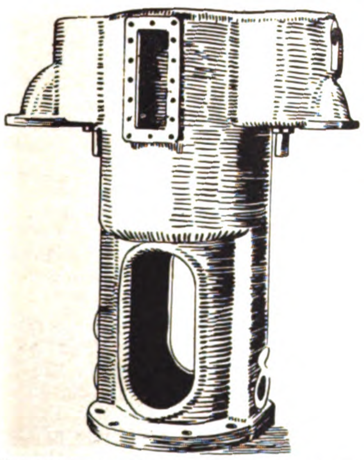
ENGINE ROOM ARRANGEMENT SHOWING THE 600 H. P. MOTOR OF "RAMON"



EIGHT-CYLINDER 600 H. P. MOTOR INSTALLATION IN THE "RAMON"

cooled; the water being admitted into the hollow valve stem from the main circulating system. The construction is shown in the accompanying sketch.

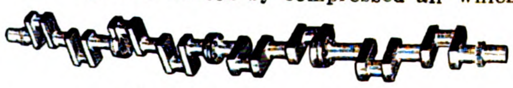
The vaporization of the fuel is accomplished by means of two carburetors used in conjunction with two exhaust heated inlet manifolds of special construction. By this means a remarkable flexibility is obtained. Smoothness of operation is still further increased by injecting water into



OPEN CROSSHEAD CYLINDER SHOWING WATER-JACKETED GUIDES AND LARGE HAND-HOLES

through a small carburetor attached to the inlet pipe just above the main carburetor.

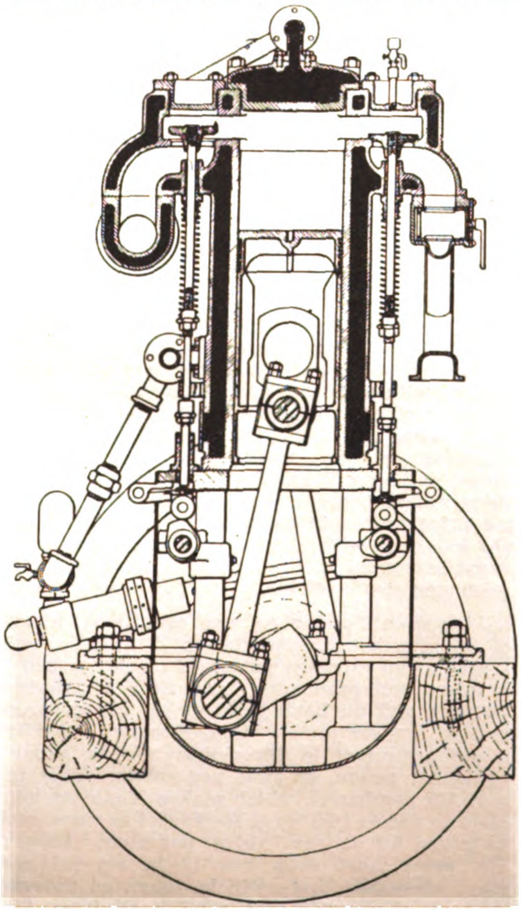
The engine is started by compressed air which



EIGHT-THROW CRANK-SHAFT

is admitted to the cylinders through a distributing valve. Although the normal speed of the engine under full power is 210 r. p. m. it may be reduced to 40 to 50 r. p. m. for manoeuvering or when running idle.

The engine is located in the center of the hull and is connected through disc clutches to four-bladed propellers at either end. The wheels are 72 inches in diameter. As the two propellers are of opposite pitch, the direction of the boat is controlled by engaging either one clutch or the other,



CROSS-SECTION OF THE OPEN-CROSSHEAD TYPE ENGINE USED IN THE "RAMON"

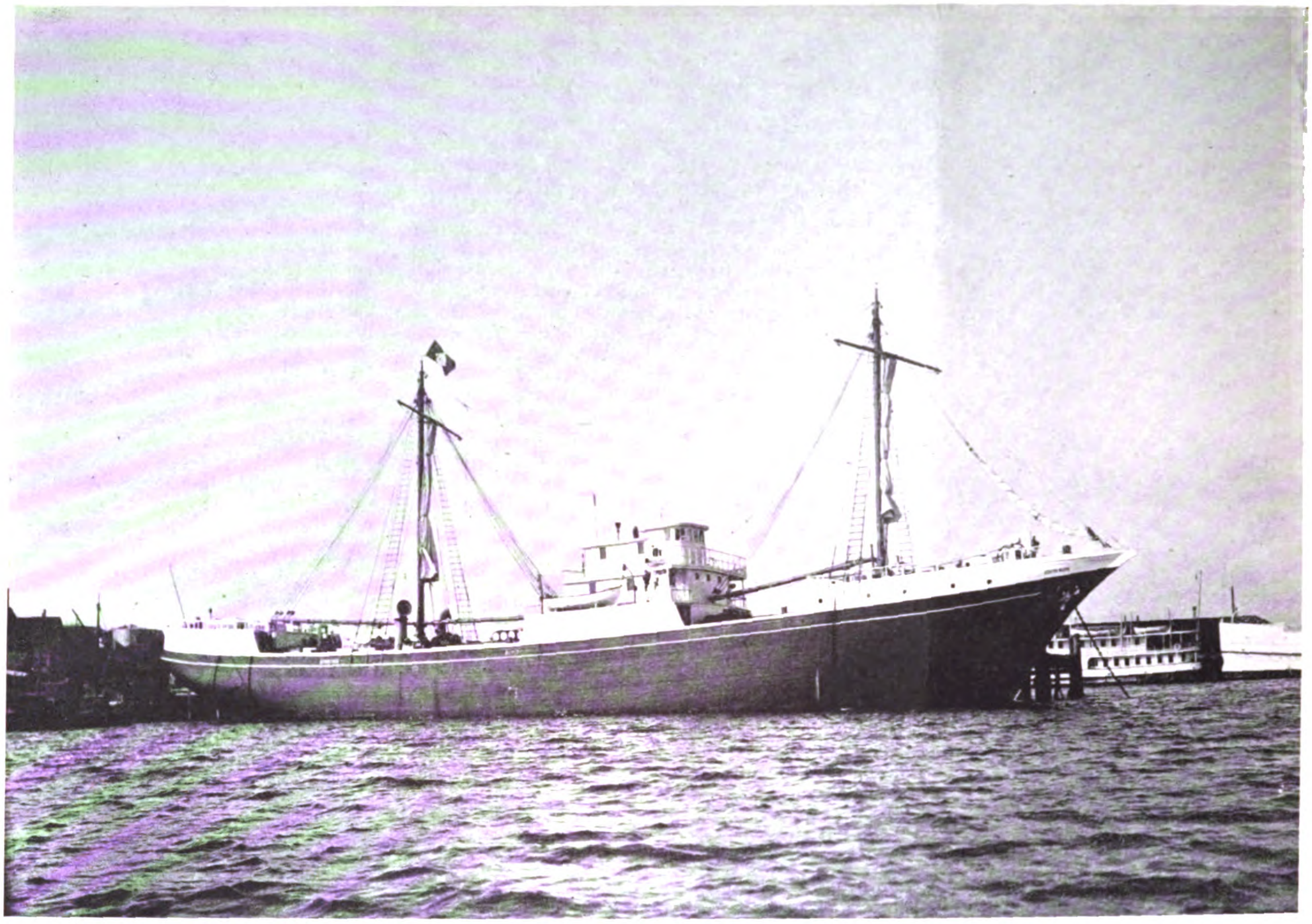
thus eliminating all necessity for reverse gears or making the motor directly reversible.

Located on an intermediate deck at one end of the engine room, is an auxiliary engine of 20 h. p. which is coupled to a generator for lighting the vessel, for pumping and other power purposes.

CONSTRUCTION OF WATER-COOLED EXHAUST-VALVES

This generator also supplies current for lighting the cars in transit. A special circuit on the train is provided especially for this purpose.

This installation of 600 h. p. requires but one engineer; this being a considerable reduction in the number necessary for the operation of a steam unit of equal capacity. Another saving is effected in the elimination of all fuel expense while the vessel is tied up between runs, and it is this consideration that will undoubtedly lead to the further development of the internal combustion engine for ferry boat service.



MOTORSHIP "EDITH NUTE"

The American designed, built, owned and engined, full-powered, twin-screw Diesel ship "Edith Nute," owned by the Atlantic Maritime Company, of Boston, Mass. The "Edith Nute" was described on page 7 of the November number of Motorship. She has a d. w. c. of 1,300 tons

Peanut Oil as Fuel for Motorships

THE successful use under ordinary ocean-going conditions of peanut-oil as fuel by the big motorship "France" opens up a great possibility for the future, and it leaves one striking impression, namely, that Diesel-driven mercantile and naval motor-vessels no longer need be dependent upon the supply of mineral oils. Hitherto, vegetable-oils have been too expensive and insufficiently distributed to consider using as fuel for merchant ships; but, the practical and successful demonstration of peanut-oil changes all this, as, in conjunction with the economical Diesel engine, it will be possible to make its adoption as fuel far more general, provided some great American development company, such as the American International Corporation, will interest themselves in its production and distribution. It may be beneficial for some important domestic oil company to take up the matter.

France, of course, obtains her supply of peanuts from Northwest Africa, so that transportation is fairly simple and peanut-oil is fairly plentiful and cheap in France in consequence. America, too, has large quantities of peanuts right at her door, most of which now are grown for peanut-butter, confectionery-products, forage (oil-cakes), and for selling at street corners by Italians to the tune of the familiar whistle. In future this particularly annoying sound will serve the good purpose of reminding shipowners that in the roasting-can is a product which will make excellent and cheap fuel for his ships—if driven by Diesel motors.

Down South, many of the cotton growers now are planting large areas of land with peanuts, and the Interstate Cottonseed Crushery Association expects a peanut crop this season of one hundred million bushels. Yet it is declared by the association that the estimate of the Department of Agriculture, to the effect that two million acres of cotton-growing land are devoted to peanuts, is underestimated by half-a-million acres. Also that ere long the cotton oil mills of the South will drop "cotton" from their titles, because the crushing of peanuts will make up a large part of their operation.

Many of the cotton mills of today are equipped for crushing peanuts, and many cotton pressing mills can quickly be re-adjusted to grind peanuts. The following ground is said, by the Bureau of Crop Estimates, to be planted with peanuts: Alabama, 980,000 acres; Georgia, 500,000 acres; Florida, 375,000 acres; Virginia, 158,000 acres; Texas, 60,000 acres; Oklahoma, 14,000; South Carolina, 22,000 acres; Tennessee, 15,000 acres; Mississippi, 25,000 acres; Louisiana, 35,000, and other states, 17,000 acres. This gives a total of 2,201,000 acres available today, and it should not take long to double this amount if necessary.

Evidently the use of peanut-oil has not been overlooked by British interests, as over fifty-thousand tons of peanuts were imported into the port of Bristol, England, during the year ending April, 1916, compared with five tons the previous twelve months. This supply came from West Africa.

Of course, other vegetable oils may successfully be used with marine Diesel engines, and it mainly is a case of cost and supply. If peanut-oil cannot be produced at sufficiently low cost for use under steam-boilers, the wonderful economy of the Diesel engine will enable its adoption for motorships unless the cost exceeds $10 per barrel. If the price proves to be in the neighborhood of $2 per barrel it will afford the oil-engine great economy compared with mineral oil at $1.50 per barrel under steam-boilers.

At present, owing to war conditions, absence of competition, transportation difficulties, labor troubles and rapacity and greed on the part of the growers and producers, the prices of American peanuts and oil have gone up all out of proportion to pre-war prices. Consequently, the cost of crude peanut-oil in the South now is about 18 cents per pound, or $1.35 per gallon. That is to say, $57 per barrel, which makes it almost impossible to use as fuel, even for Diesel engines, which only use 0.3 lb. per i. h. p. per hour. However, the price must drop heavily in several years' time, otherwise there will be imported thousands of tons of peanuts or the oil itself from Africa and other places—and there will be ships available for the purpose.

THE McCORMICK FLEET.

The fleet of motorships owned by Chas. R. McCormick & Co. of this city will be increased to four by the completion of the motorship "J. W. Wells," which will be finished this spring. Each vessel constructed by this company is larger than its predecessor. The "City of Portland" was built late in 1915 and has since made two trips to Australia as the pioneer motorship of this type. She is 275 feet in length over all, 48 feet 2 inches beam and 21 feet 1 inch moulded depth. She has a capacity of 2,120 tons and is equipped with twin 320 h. p. Bolinder engines. The "Allard" was completed last year and has since made one trip to Australia. Her dimensions are: length, 278 feet; beam, 48 feet 2 inches; moulded depth, 21 feet 9 inches. Her capacity is 2,600 tons. The third vessel, "City of St. Helens," was completed this year and is at present on her maiden voyage to Australia. She is 285 feet over all, 48 feet 2 inches beam and moulded depth of 24 feet 6 inches. Her capacity is 3,300 tons. The "J. W. Wells" will be five feet longer than the "St. Helens" and is expected to have about 3,800 tons capacity.

All these vessels have the same type of engine and electric steering gear. The latter was designed and built by the Herzog Electric and Engineering Co., of San Francisco. The power is taken off the auxiliary electric light motor and by this arrangement very little additional power is needed for steering. Experience has shown that 2 h. p. for the steering gear is excessive at all times. The vessels each carry 1,600 bbls. of fuel oil, which gives them a cruising area of about 13,000 miles without the necessity of refueling.

The average time made by these motorships has been 13 days from the Columbia river to Honolulu and 26 days from the same port to Sydney, Australia.

TOO LATE!

The Pierce Navigation company of New York had been seriously considering installing oil-engine power in their schooner "El Calloa." While the matter was under consideration the vessel was driven ashore near Tampico during a northwest gale and became a total wreck.

The Influence of the War on the Submarine Policy

By MARLEY F. HAY, Esq.

Member Society of Naval Architects and Marine Engineers.

THE outbreak of war in August, 1914, found the supreme naval power, Great Britain, in possession of the numerically strongest submarine fleet. It comprised about 90 vessels ranging, with a few experimental exceptions, from 200 to 800 tons in displacement.

The submarine at that time was admittedly and manifestly the weapon of the weaker power, inasmuch as it was presumably a weapon pre-eminently of defense and it was hardly deemed politic for secondary or lesser powers to entertain aggressive national policies. Moreover, the tremendous pecuniary burdens involved in the acquisition and maintenance of a fleet of capital ships reduced this policy of defense to a policy of necessity. So conclusively is this the case that certain of the smaller powers have conceded the principle that, militarily speaking, submarines should form the major part of their fleet with only a certain number of destroyers and auxiliaries as supports.

While the principle has been fully recognized in theory, a subtle but powerful consideration has tended to prevent its full implementation in practice, namely, the service or personnel necessity for large ships. An exclusively submarine navy would provide no sea commands for officers who had passed their thirtieth or thirty-fifth year, so that large ships have been incorporated in the fleet if for no other purpose than to provide higher commands for older officers and to offer sufficient incentive for young men to enter the naval service, without which prospect the ranks of the Naval Academy would have been hopelessly depleted. This has constituted the principal motivation for large ships in certain concrete instances. During the nineteenth century, Great Britain has occupied the position of supreme naval power, hence all other powers have been comparatively and relatively in the position of navally weaker powers. The logical result of this status should have caused the British Admiralty to discourage early efforts to establish the practicability of the submarine, and that the situation was thus appreciated is evidenced by the fact that Robert Fulton, the American inventor of an early type of submarine, was offered substantial remuneration by the Admiralty for the entire suppression of his patents and ideas. This occurred a century ago after his failure to obtain recognition in America and France.

In 1914 Great Britain's numerical superiority in submarines was probably attributable to a belief in the suitability of submarines for coast and harbor defense, which had in fact been amply demonstrated by their success in the naval maneuvers of the preceding five years. The utilization of submarines for coast and harbor defense naturally released a certain part of their fleet for other and possibly more important work.

In a consideration of the effect of the war upon submarine policy, we are immediately concerned with the principal belligerents, and especially the central empires, whose sea policy has brought submarines into such prominence.

On the allied side, France entered the world conflict with a heterogeneous assemblage of submarines, about fifty in number, with the widest range of variation, both in regard to displacement and military characteristics.

The Russian submarine flotilla has played a very inconspicuous role in the operations that have taken place hitherto and can hardly be said to have influenced submarine policy, either technically or strategically. By and large, the same may be said of the other allied powers, and the comparatively late entrance of the United States as a belligerent, if nothing else, would account for the inactivity of American submarines as far as the major naval operations in the North Sea and in the waters surrounding the British Isles are concerned.

It may fairly be assumed, however, that since April last this country has profited at least potentially by the previous war experience of the western allies. Paradoxical as it may seem in the light of later developments, the last of the great powers to admit the desirability of or necessity for submarines was Germany, and that conclusion was only reached under the pressure of actual war, when it was manifest that the rest of her fleet was of practically no use. If one believes that the German government has been preparing for many years in anticipation of the present war, it seems incredible in view of the completeness of her preparedness in all other respects that the submarine arm of the naval service was neglected and discredited up to the day that war broke out. It was assuredly no oversight on the part of the German authorities, for in several conversations the writer had with Admiral von Tirpitz in 1911 in regard to Germany's submarine policy the latter expressed emphatically as his opinion that he considered submarines to be in an experimental stage, of doubtful utility, and that the German government was not at all convinced that they would form an essential or conspicuous part of their future naval programs. This opinion, which undoubtedly incorporated the opinion of his principal subordinates, was not expressed with any purpose of misleading, for it was a well-known fact at the time to every one in the profession that Germany's position in the matter of submarines was that of a third-class power.

When hostilities commenced Germany had twenty-five submarines in commission and was building perhaps half a dozen more. They were all of the Krupp-Germania type, and von Tirpitz explained almost apologetically that they had built a few just to be able to form some conclusions regarding them based on their own experience. It was evident at that time, however, that no great thought or attention was being devoted to their development, nor were ideas from outside sought.

Any casual student of European politics during the last fifteen years knows that in every international complication that arose and threatened European peace Germany was always to be found on one side and England on the other side as potential antagonists. If Germany had foreseen every contingency and provided for it in advance, she must necessarily have regarded the participation of England as an adversary in the present conflict, or, in fact, in any conflict in which Germany was involved, as a possibility at least, even if a remote one, and she must also have foreseen that the participation of England would bring about the enforced inactivity of the German high-sea fleet.

She could also have foreseen the situation that now prevails, i. e., the submarine branch of her naval service would be the only one that could deliver any effective blows against England. Under these circumstances, how is it possible to explain the utter failure of the German government to comprehend, or, if they comprehend, to provide for the role that submarines are playing today? Is it possible the General Staff and the Reichs Marine-amt refused to recognize the possibility of England's participation as even a remote contingency, and that no appropriate preparation was made to meet it? It would almost seem so, for when England definitely entered into the conflict against Germany steps were taken in feverish haste to lay down over sixty submarines at once, and that number has since been largely augmented.

Estimates have appeared in print according to which Germany was credited with having over 700 submarines in her possession last May and that 1,200 would be in commission by the end of this year. It can hardly be possible that such an estimate has been made by any person familiar with the shipbuilding facilities of Germany, even making all due allowance for abnormal expansion of these facilities to meet the necessities of the occasion. It has been stated that drydocks would even be utilized for the purpose of erecting them, as if the problem were primarily one of ground space.

The entire shipbuilding capacity of Germany is very limited, compared with England, for instance, and the difficulty of finding highly trained and skilled shipbuilding labor such as is required for the intricate work of constructing a submarine would militate heavily against any sudden increase in the tonnage that could be turned out. Taking into account all the shipbuilding facilities of Germany, both private and governmental, making the most liberal allowance for the maximum extension of these facilities under pressure of war, bearing in mind at the same time the difficulty experienced in obtaining certain necessary machinery and appliances and in obtaining skilled labor, and deducting the number of submarines that have probably been lost or destroyed by the enemy, it does not seem possible that Germany had more than 200 submarines in commission last May. Of this number approximately two-thirds would be constantly available for duty, while the other one-third would be en route either to or from the various shore bases for the replenishment of supplies and for repairs.

To arrive at a fair or accurate estimate of the rate at which Germany can build submarines in the future is somewhat more difficult. Assuming, however, that all yards in the country were utilized exclusively for this kind of work and that no mercantile shipbuilding or repairs to the battle fleet were undertaken, which, of course, is far from being the case, the probability is that not more than 100 submarines could be completed every six months.

Information at hand would indicate that the actual recent output has been approximately 10 per month, of which the great majority are in the neighborhood of 800 tons to 1,000 tons displacement. Several groups of about 1,500 tons have also been commissioned and quite recently the construction of a flotilla of 8 so-called submarine cruisers of 2,800 tons displacement has been undertaken of which 3 or more are reported completed and the remainder will be ready for service by next February. These vessels will mount two 6-inch guns, besides two guns of lighter caliber, and embody the innovation of an armored conning-tower. This is more or less essential where the conning-tower constitutes the central control station of the vessel and at the same time is the most vulnerable part. It is only feasible, however, on vessels of great size, because of submerged stability considerations.

All the later Austrian submarines have been manufactured in Fiume and Trieste from German plans and constitute, in effect, a German submarine flotilla in the Mediterranean that has avoided the necessity of the hazardous journey from the North Sea through the Straits of Gibraltar.

Turkey and Bulgaria have not been contributory factors in the submarine plan of campaign.

The effect of the war on the submarine policy of Germany has manifested itself in a tremendous program of acceleration and access of numerical strength with increase in displacement and radius of action, as hereinbefore indicated, to meet the exigencies of long cruises off the west cost of the British Isles, necessitated by the effectual closure of the English Channel.

It is not at all clear that before the war any of the allied powers, or for that matter the central powers, seriously anticipated or contemplated the possibility of ruthless submarine tactics against merchant shipping as at present employed by Germany. Nevertheless, some years before the war there was a lively discussion in the British press of certain alarmist literature, notably a book by Sir A. Conan Doyle, in which ruthless submarine warfare at its worst against merchant and passenger vessels was portrayed with grim accuracy. It was generally, if uncomfortably, dismissed as grotesquely fantastic with at the same time a secret hope that eventual enemies might fail to apprehend the pregnancy of the suggestion. The initiation of the sinking-on-sight policy was justified by its authors as another of those convenient "military necessities," the results of which would sanction its utilization.

That it was not a predetermined policy before the outbreak of war appears to be evidenced by the fact of Germany's complete unpreparedness at that time to conduct submarine warfare, coupled with the further fact that the design of the earlier German submarines indicated the intention of anti-warship rather than anti-merchantman tactics. Be that as it may, when the German submarine campaign was finally launched against the Allies in all its ferocity, academic questions regarding the presumptive policy of its inception had to give way to the physical fact of its reality and the necessity of counteracting it by every possible means. At a very early stage in the war, certain important areas were defended by a series of nets with various devices to indicate the presence of a submarine in the net and so aid in its capture or destruction. Large numbers of high-speed patrol launches mounting a 2-inch or 3-inch gun were employed to hunt and shoot down exposed conning-towers or hulls, and destroyers were rapidly fitted with emergency rams to permit them to charge submarines on sight with a fair chance of success without undue damage to themselves.

The immediate effect of these tactics on the part of the Allies produced the countermeasures

of knife-edges and net cutters at the bow to facilitate penetration of the net, clearing lines and similar devices protecting all projecting parts to the same end, and housing periscopes to bring the top lenses in the housed position, below the clearing lines.

The larger submarines then under construction increased their armament to guns of 4-inch caliber to outrange the patrol boats, and the latest vessels with 6-inch guns are formidable opponents of a destroyer. The danger of ramming induced a radical increase in the length of the periscopes up to about 10 meters in some of the latest boats. By this means it is possible to keep a lookout in fairly rough weather with several feet of periscope exposed and at the same time maintain a sufficient depth of water above the vessel herself to practically preclude the possibility of successfully ramming. The conning-tower remains as the only vulnerable part in this condition, and the destruction of the tower, while serious enough, by no means entails the loss of the boat.

To reduce resistance to propulsion submerged and at the same time obtain sufficient rigidity in the free portion of periscope above the highest bearing, the use of these extremely long periscopes has necessitated an increase of the housing distance to the greatest practicable degree, the eye-piece in some cases being almost in the bottom of the boat when the periscope is fully housed.

The ubiquity of vigilant patrols and destroyers, frequently making no invidious distinctions between friend and foe, has necessitated on both sides a revised conception of quick transition from the surface condition to the submerged condition, whether statically or dynamically. The necessary sequence of operations to bring about this transition, which in time of peace were customarily performed consecutively, are now perforce executed simultaneously, and any practical expedient by which seconds may be saved is unhesitatingly adopted. Upon a given signal the engines are stopped, exhaust pipes closed, clutch to main shaft disengaged, conning-tower hatch closed, ventilators closed down, motors started, kingston valves and vents for flooding main ballast tanks opened and the crew all stand by at battle stations.

To still further expedite this maneuver the allied submarines navigate frequently with open kingstons, depending upon air pressure in the ballast tanks to regulate the ingress of water. The Germans, on the other hand, maintain a partial vacuum in the empty ballast tanks which in effect approximately doubles the head of water. As the tanks must, in the nature of the case, be filled while the vessel is still on the surface the head of water can never exceed the draught of the vessel, and even this comparatively low head is steadily reduced by the filling of the tank. With a given total area of kingston valves, the increased rapidity with which the water will flood a tank containing a partial vacuum instead of air at atmospheric pressure will be apparent. The usual vent pipes to permit the escape of air from the tanks are also fitted, and these are opened as soon as the vacuum gauge on the tanks indicates the re-establishment of atmospheric pressure. The partial vacuum in the tanks is obtained by pumping out the air with the usual high-pressure air compressors that are installed for air service purposes.

The system is open to the objection that an emergency might arise demanding quick submergence shortly after a previous emergence and, before sufficient time has elapsed, to produce underpressure in the tanks. As the time required is comparatively short, however, and even a few inches of vacuum are effective in increasing the rapidity of flow, this disadvantage is relatively insignificant.

At an early stage it was apparent to the German authorities that the expenditure of 20-inch or 18-inch torpedoes on merchant ships represented wasted energy; moreover, the number of tubes and torpedoes of that size that a vessel could carry was relatively limited. At the same time, the general policy of defensively arming merchant ships militated against the German practice of coming to the surface and leisurely sinking the victim with a few inexpensive bombs placed on board or several well-directed shots from the gun, for which two to three hundred rounds of ammunition could be stowed.

These considerations, taken in conjunction, indicated the desirability of evolving a new type of small torpedo proportionate to the work to be done, of which a larger number could be carried on board than would be possible with 18-inch or 20-inch torpedoes within equal limitations of weight and space. This led to the adoption of the 14-inch torpedo and permitted the installation of approximately twice as many tubes and torpedoes in a given design.

The experience of the war has taught submarine officers to make the most of the virtue of invisibility; showing more than the top of a periscope during the twenty hours of daylight in the summer months is an undue risk not to be taken without sufficient reason. The energy of the battery must be conserved, however, to be available when needed in an emergency. To that end arrangements have been perfected to facilitate what is variously known as balancing, statical diving or suspending. With a minimum expenditure of power, the vessel remains stationary in the submerged condition with only the tops of the fully extended periscopes exposed. With the sensitive listening devices now extant it is of vital importance that this mechanism be as nearly noiseless as possible and that no air bubbles escape to betray the presence of the boat. By housing the periscopes during this maneuver, nothing is visible above the surface of the water.

It is sometimes employed when close pressed to elude pursuit when the depth of water is too great to permit descent to the bottom.

Another method of economizing battery energy frequently resorted to consists in navigating the vessel with the ballast tanks full and ready for diving under the Diesel engine. The only exposed portion in this condition is the conning-tower fairwater, and that is not a measure of the actual reserve buoyancy, for the apparent freeboard is due to the dynamic effect of propelling the vessel forward in this condition with the stern diving rudders set slightly to rise. The hatches all being closed, the air for the engine is supplied by a quick-closing ventilator.

This operation was regarded dubiously before the war, but its success has justified its wide adoption, so that what was once considered a precarious expedient has now become commonplace routine. Doubts were felt regarding the possible effect on the crew of a sudden inadvertent closure of the ventilator supplying air to the engines and a consequent rapid drop in internal pressure. In practice the effect on the crew is nil, other than a momentarily disagreeable numb sensation in the ear drums.

The use of nets in this war as a defense against submarines and the desirability of evading these entanglements by diving below them will probably lead in course of time, if it has not already done so, to the consideration of increasing the strength of the pressure hull to make submergence to a depth of 300 or 400 feet a practical possibility, instead of the working limit of 200 feet that generally obtains today. To accomplish this result a certain rather serious sacrifice of other military qualities will be, of course, inevitable.

During the first years of the war little success was experienced in combating submarines with submarines principally for the reason that their reciprocal invisibility militated against their finding each other except when one was on the surface. Later developments in submarine signalling and sound-detecting devices have made it possible, however to hear a submarine even when it cannot be seen, and also to approximate its direction. That being the case, it is quite conceivable that a numerous flotilla of submarines submerged statically in suspected areas with only the periscope objective exposed might lie in wait until the sound of the enemy's propellers or the hum of the electric motors became audible. In all probability the sound of the propellers would be heard first and the comparatively high rotative speed should distinguish it from the propellers of an ordinary vessel. In any case a look through the periscope would resolve any doubt on the subject.

Proceeding in the direction whence the sound came, an effort would be made to locate the enemy's periscope and get within torpedo range. Any submarines now in commission provided with the latest listening plates could perform the function of a submarine patrol with a certain degree of success, but it is evident that a submarine designed especially for this kind of work, in short a contra-submarine, would logically depart considerably from the characteristics of submarines proper as we now know them.

The evolution of a radically different type would involve for every nation the creation of a flotilla of contra-submarines to oppose the submarines the enemy would send against her. It is, of course, possible to make a compromise design combining the essential characteristics of the submarine-versus-warship type with the submarine-versus-submarine type, but such a compromise is not compatible with the highest requirements of either and is likely to entail the weak points of both and the preeminent advantages of neither.

For that reason two distinct and separate types are to be preferred.

The contra-submarine will do practically all of her work submerged. Therefore the displacement should be sufficient to ensure satisfactory habitability, and a very powerful battery and large motor should be installed to give the maximum possible endurance submerged and the highest submerged speed at the maximum discharge rate of the battery.

On the other hand, battery efficiency expressed in output per pound of weight is highest when the individual cells are not too large, especially when the vertical measurement is at a minimum, nor is it desirable to unduly increase the voltage. Hence practical limitations are imposed which will possibly determine 500 to 600 tons as a satisfactory surface displacement.

Facility of maneuvering submerged also inhibits too great a displacement.

Everything that contributes to resistance submerged should be examined critically with a view to reduction or elimination. The conning-tower and periscope complex adds about 35 per cent to the total resistance, out of all proportion to its relative size. The periscopes naturally cannot be omitted, but a large reduction in resistance may be effected by restricting the function of the conning-tower to that of a simple entrance hatch to permit ingress and egress in heavy weather and reducing its section to the "irreducible minimum." If made of nonpressure-tight construction it could be of elliptical section and still further reduce its eddy-making propensities.

In certain French submarines built before the war the idea of reducing resistance submerged was carried to the extent of eliminating the conning-tower altogether and fitting in its place a canvas weathercloth to protect the entrance hatch in heavy weather. Thus the boat was virtually destitute of an entrance hatch that could be safely opened when seas were breaking continuously over the deck. After a few disagreeable experiences the practice was discontinued. There is no good reason, however, why the conning-tower or, properly speaking, the entrance hatch in this special case, should not be made housing to be elevated only when weather conditions require it.

Docking keels, bilge keels and other power-consuming hull appendages should be dispensed with, to the limit of absolute indispensability.

As for armament, the same process of logical reasoning that induced Germany to adopt 14-inch torpedoes would obtain in this case, although the writer believes that still smaller torpedoes, say of 12-inch diameter, would be preferable.

In stalking an enemy submarine, it is not likely that more than one opportunity to fire at point-blank range would be presented, and with the extremely long periscopes now in use there is no means of ascertaining whether the enemy whose periscope is sighted is 8 feet or 20 feet or more below the surface.

With housing periscopes adapted to be used in practically any position, the length of exposed portion of periscope no longer indicates the depth of the boat, so the possibility of a torpedo going over or under the target due to this uncertainty is considerable.

To reduce the influence of this disability to a minimum as many tubes as possible should be grouped for simultaneous firing, arranged at slightly divergent angles, with torpedoes set for various depths so that dispersed fire is obtained on the principle of a shot-gun.

Such a group of tubes can more readily be fitted in the bow than elsewhere. It is important, however, that the contra-submarine should have as great an arc of fire as possible with the minimum necessity for training the boat in azimuth, for which reason a battery of perhaps four stern tubes could be installed. Broadside tubes do not lend themselves readily to this arrangement, especially as each group could only be fired on one side. This consideration, together with the difficulty of firing from bow tubes at point-blank range in a vessel of large displacement, constitutes another argument against unduly increasing the displacement of these vessels.

They should, of course, be self-sustaining, therefore equipped with Diesel engines to charge the batteries in not over four hours. Therein lies their greatest vunerability, although in that respect they are in a similar case with any other type of submarine. During the period of battery charging at night, they must not only come to the surface and sacrifice the immunity of invisibility, but the noise of the Diesel engine ex-

(Continued on Page 16)

Motorships and Their Operation

Series III

THE "STARLITE" AND HER FIVE SISTERS

(We believe these articles on "Motorships and their Operation" are doing splendid work by establishing confidence of motor power in the minds of those steamship owners, who previously regarded with a certain amount of distrust any form of propulsion other than that of coal-burning machinery. Certainly these articles are doing much to eliminate any trepidation or nervousness that many domestic shipowners still show when it comes to the actual point of investing their hard-earned money in motorship construction. We have received some excellent and encouraging compliments over this series, and with the complete co-operation of shipowners we will continue them, although to do so properly it sometimes becomes necessary to be a little frank, which we are sure will be accepted in the same completely friendly spirit by all those concerned. In the past, prejudices have been created by lack of discussion on the various so termed "motorship failures," which must not be left as undisturbed recollections in the minds of those shipowners who still are wavering in their beliefs and views.—The Editor.)

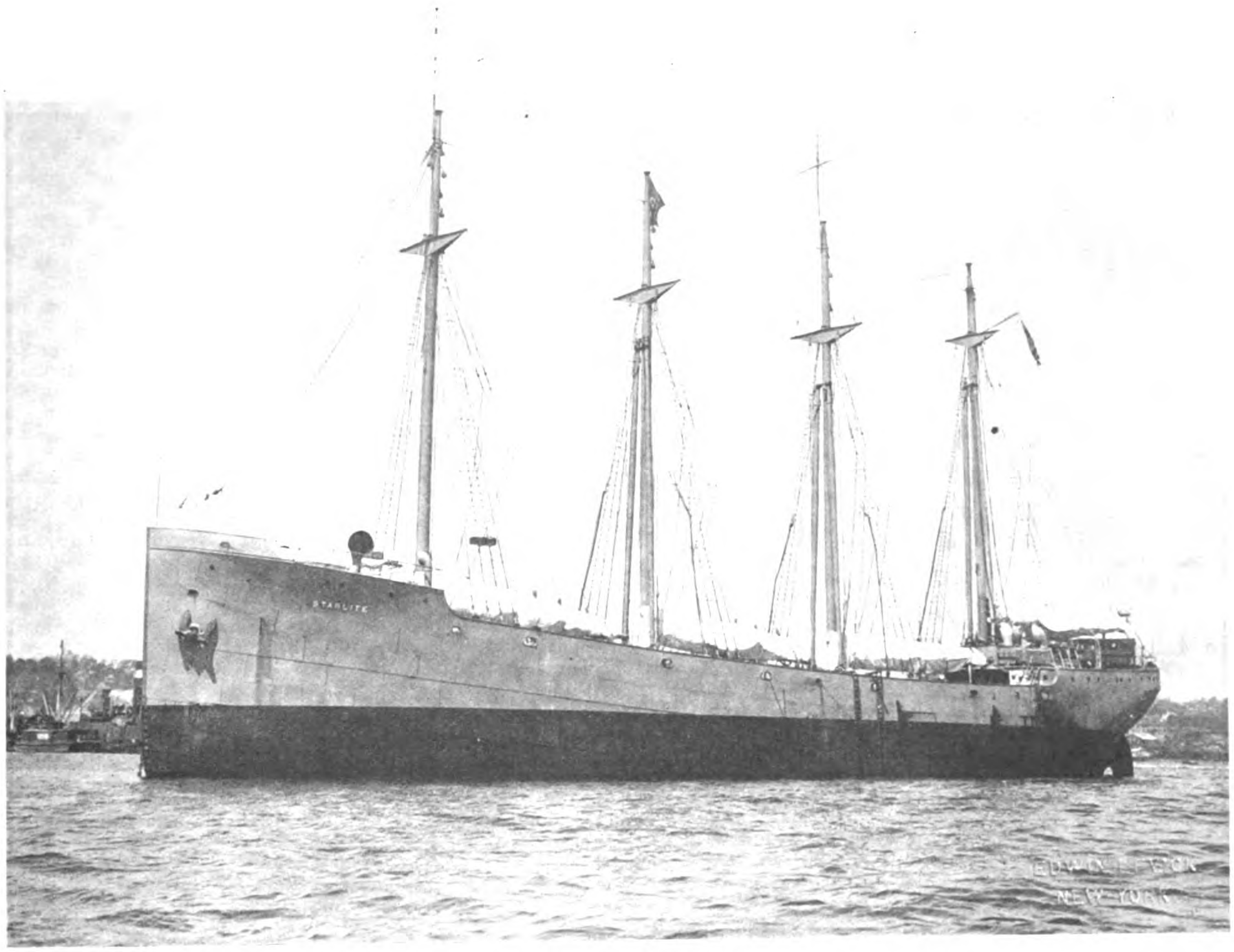
AMONG the fleet of motor-driven vessels owned by one of America's most important oil companies, are six sister auxiliary schooners known as the "Daylite," "Starlite," "Dawnlite," "Twilite," "Sunlite," and "Moonlite," all designed and built in this country, and equipped with oil-engines imported from Sweden. Unfortunately, some misunderstanding seems to exist regarding the operations of these vessels, which has not increased the prestige of motorships with American steamship owners. But, in our opinion better results could not have been obtained had any kind of steam power of the same output been installed, and, in a sense the running of these ships is more a credit than otherwise to their internal-combustion-motors.

It perhaps is advisable to look backwards several years. In the earliest days of the war, a wide-awake and far-sighted real-estate dealer entered the shipping circles of New York, because, we understand, he was primarily concerned with the shipment of horses to Europe. He is said to have made a fortune when many more conservative shipowners sat tight awaiting developments of the then critical shipping situation. Here was the infusion of fresh blood into the Atlantic Coast shipping, which meant the introduction of a certain amount of new and more modern ideas of ocean-going transportation, for it was hardly possible for such a man to have any fixed beliefs on methods of propulsion the same as would an old shipowner brought up with coal-burning steamers. Consequently, it would not be surprising to find his ideas sufficiently advanced in nature to disturb some of our older and conservative shipowners, who seem to have in the past preferred to play "safety-first" by steadfastly adhering to coal-produced steam propulsion, of which they felt sure, without "fooling around" with new-fangled schemes, such as internal-combustion-oil-motor power.

Being new to the shipowning business this man was not surrounded by old traditions, nor had he gradually drifted into a groove. So he was well able to note, and consider with an open mind, what successful shipowners were accomplishing abroad, where economic necessity had caused a much more rapid development of the high-powered marine oil-engine. Thus, the remarkable advantages of motorships evidently were apparent to him, for he ordered many such motorcraft, including the six auxiliary vessels just mentioned.

But, there seems to have been a little flaw in the diamond! The absence of previous technical experience with motorships possibly was this flaw! Had he all the benefits of the broader and more technical experiences of the older men in the steam ownership business we do not think that these six ships would have been constructed in their present underpowered and undercanvased form. There is nothing disparaging, but a great deal of truth, in the old saying that we all pay to learn, and rarely is there an exception. We all learn by experience, and when we learn by mistakes the experience is all the more valuable to us. Such is human nature!

The havoc made by German submarines among oil-tankers caused a very serious shortage of oil-carrying ships. Here were six steel vessels nearly ready and capable of carrying a total of over 16,164 tons of case-oil cargo in their holds. Their present owners purchased them, fully aware that they were not ideal ships as they then stood; but, their services have enabled them to retain their South American trade. We have heard that not long ago the oil company in question was offered $600,000 apiece for them, but preferred not to sell, showing that these ships, even if underpowered, have a considerable value over their original price.



MOTORSHIP "STARLITE"

Now, these ships presumably are sailing-vessels with auxiliary power; but, the sail spread is totally inadequate, while the small amount of power installed is quite insufficient to propel them at sea at any reasonable speed, although it is enough to move the ships in and out of harbor, or for giving them steering-way in a fairly calm sea against a moderate wind.

The maximum continuous power of the propelling oil-engine in each ship is 320 b. h. p., they being single-screw boats with one four-cylinder motor apiece. The amount of canvas carried is but 11,000 square-feet. (This now is being added

to by the present owners). Seeing that these vessels can carry over 2,694 tons of cargo in their holds (2900 tons d. w.) when on an even keel draught of 8" less than their designed draught of 18' 6", and that their beam is 43' 6", it is easy to understand why they are underpowered.

The loaded displacement per ship is 4,270 tons, and the urgency of quick service, together with their slow sailing speed, have been the factors that necessitated the using of the motor-power as continuously as possible on all voyages. This we consider somewhat equivalent to running a big seven-seated Packard chassis and body, but with a little Ford engine, and with all passengers aboard, up an endless hill on top gear day after day for as long as three and four weeks without stopping. Under such conditions no machinery could stand the strain—and we include steam-engines—for, this 320 horse-power has had to drive 4,270 tons against the current and often against the wind as well. Therefore, is it any wonder that a certain amount of trouble has been experienced? Unfortunately, there are some who have seized the opportunity to suggest to steam shipowners that—"here is another bunch of motorship failures"—regardless of circumstances that needed proper discrimination before forming such an opinion.

We are glad to have been afforded the opportunity of bringing the facts to the light, and thus refute idle, and careless, and even unfriendly rumors. We cannot speak too highly of the present owners for having placed the facilities at our disposal, and for kindly giving us so much of their time at a period when they are exceedingly busy. They have made efforts to the best of their ability to encourage the use of and to develop the oil-engined vessel in the United States, and have not hesitated in the past to spend large sums of money for experimenting along this direction.

We think we have made it clear that, no matter what trouble has occurred during the running of these ships, it has not been due to a fundamental fault of the oil-engine system of propulsion, the motors having had to operate under exceptionally difficult and severe circumstances—conditions under which steam power rarely has to contend with. To make these ships successful, our suggestion to the present owners is that if possible they treble the motor power as soon as feasible. They already are adding to the sail spread!

Perhaps, it may be possible to make them twin-screw vessels and install two 500 b. h. p. motors of the same surface-ignition type as now installed; or else have built and install a single 1,000 b. h. p. heavy-duty Diesel engine for each ship. Either arrangement should give the vessels a sustained speed, when loaded, of 8 to 9 knots under general service conditions, or 9 to 11 knots when under both sail and power in a favorable breeze. We have no desire to instruct shipowners how to run ships, but in such instances we believe our friendly suggestions will be welcome. We understand too that the present propellers are not suitable for the power installed, in fact, the amount of slip indicates this.

We will proceed to deal with the operation of the machinery during the voyages of the "Starlite," which we take for illustration because the running of the other five ships has been better. First, however, we will give a few details regarding her dimensions, as follows:

Length o. a., 261 ft.
Length b. p., 252 ft.
Breadth (molded), 43 ft. 6 in.
Depth (molded), 23 ft. 6 in.
Loaded draught (designed), 18 ft. 6 in.
Loaded draught (official), 18 ft. 10.26 in.
Displacement (loaded), 4,270 tons.
Deadweight capacity, 2,914 tons.
Cargo capacity (case-oil), 2,694 tons (about), or 59,000 cases.
Weight of ship (light), 1,356 tons.
Grain space, 163,580 cu. ft.
Bale space, 153,244 cu. ft.
Sail area, 11,000 sq. ft.
Power of propelling motor, 320 b. h. p.
Ship built by Toledo Shipbuilding Co.
Ship designed by Cox & Stevens, New York.
Main engine built by Bolinder, Stockholm.
Propeller, three-bladed, 78.74 in. pitch by 55.12 in. dia., with 17.76 sq. ft. of developed blade-area.
Fuel-consumption of main-engine at full load, about 0.55 lb. per b. h. p. hour, or approximately 1/88 tons per 24-hour day.
Average total fuel-consumption of main-engine and engine-room auxiliary machinery at sea, about 14 barrels per 24-hour day.
Fuel-oil capacity, 200 tons (1,400 barrels).
Fresh-water capacity in double bottom, 126 tons.
Ballast water capacity, 252 tons.
Fresh water tanks capacity, 4,000 gallons.

The "Starlite" is of steel construction and is of the single-deck type, and has a double bottom, 3 ft. deep. She is rigged as a four-masted schooner with no bow-sprit, has a straight stem, and has four steel pole-masts 123' in height. There is a Scotch Marine type donkey-boiler, 8' diameter by 9' long, using the Dahl fuel-oil system, having a heating-surface of 576 sq. ft., and a working pressure of 150 lbs. per sq. inch. For this there is a condenser of 5,000 lbs. water capacity per hour. There is a circulating pump, a hot-well tank, one bilge and one ballast pump, one 6"x6" x6" fuel transfer pump, and one steam-driven 6KW Engberg generator with switchboard. There also is an emergency Fairbanks-Morse surface-ignition type oil-engine belted to a 6KW generator for use at sea, and a ½KW Marconi wireless set made by The Marconi Co.

The donkey-boiler is not located in the engine-room, but on the main deck in the engine-casing, where it is out of the way of the motor. This boiler is not generally used when at sea, so that the only heat arises from the hot-bulbs. We might add that the engineers' quarters are all under the poop-deck far from the engine-room heat, while in the engine-room itself the hot-bulbs and water-jacketed exhaust-chambers, or mufflers, would never bring the temperature above the comfortable, so that the temperature always is below that of the machinery space of a steamer, which is a nice feature for a ship trading between North and South America.

At the time of writing the "Starlite" has been in service about 14 months, but the period which we deal with covers about 13 months, during which time she logged 25,553 nautical miles. Her time spent at sea was 238 days 14 hours, and of this period her motor was running for 185 days 17 hours. The difference in time was due to machinery stoppages, and the log record shows that these stoppages principally were due to over-heated bearings, twice to cracked cylinder heads. The frequency of these hot-bearings clearly demonstrates that far too heavy work has been placed on the engine.

Let us put it squarely to broadminded ship-owners! Is it to be expected that a little auxiliary motor of 320 b. h. p. can drive a big steel ship of 4,270 tons loaded displacement, hour after hour, day after day, week after week (these one-way trips took as long as two months each) just as if she were a properly full-powered vessel? Should not an auxiliary motor be used as auxiliary power on occasions, instead of constantly as in the case of a full-powered vessel? Also is it any derogatory reflection upon the marine internal-combustion-motor that the oil-engine machinery of the "Starlite" and her sisters could not accomplish such work without hold-ups as have occurred? On the other hand, is it not remarkable under the circumstances that the engine has not almost shaken itself to pieces under the strain? We have given our own views and believe that the present owners will agree with us.

A clearer idea of the work that the engine had to do will be obtained from the following table of the voyages made, the average speed with both power and sail being very low, showing the correctness of our theory that the spread of canvas originally carried is quite inadequate, leaving the majority of work to be done by the auxiliary oil-motor. This last is entirely the wrong principle for an auxiliary vessel, unless the sail be auxiliary to the motor, in which case plenty of power should be installed. It is a good rule to bear in mind that an auxiliary ship should be designed and operated as an auxiliary ship, not as a full-powered vessel!

Voyage—	Distance Logged (Knots)	Fuel Consm'p. (Bbls.)	Time at Sea	Time Engine Running	Average Speed in Knots	Propeller Slip
New York to Pernambuco	5,027	420	45d	37d 12h	4.55	37%
Pernambuco to Montevideo	2,139	195	15d 7h	15d	5.84	32%
Montevideo to New York via Boston	6,550	...	58d	51d 7h	4.70	43.9%
New York to Rio de Janeiro	6,207	511	58d	45d	4.46	.....
Rio de Janeiro to Santos	210	84	3d 5h	3d 5h	1.60	.....
Santos (Brazil), to New York	5,420	399	53d 17h	53d 15h	3.80	.....

The fuel-consumption of the "Starlite" can be seen in the above table. We draw attention to the fact that in the shortest trip of the six, namely from Rio de Janeiro to Santos, a distance of but 210 nautical miles, no less than 84 barrels of fuel-oil and 111 gallons of lubricant were used. This strongly indicates that the little auxiliary propelling engine was making gallant efforts for over three days on end to push the comparatively great vessel against whatever wind and current there was. The consumption also indicates that the engine even was being forced to an overload and that the sails were practically of no help. The speed averaged being but 1.6 knots on that trip. To us it seems to have been a very creditable feat of the motor to have enabled the ship to have managed to stem the wind and tide, instead of being forced to tack like a sailing-ship without power.

(We since learn that this was the case, the captain having figured that unless they got around the cape by a certain time, changing weather conditions would have held up the ship for a considerable time.)

A study of her log extracts show the majority of engine stops to have been due to hot-bearings, hot-bearings and then hot-bearings, through all her voyages. She ran 44 days on three cylinders on one voyage. Of course, other minor troubles arose, and apparently nearly all through the strain on the engine. On an early trip she cracked two cylinder heads which afterwards were welded and used again. This seems to have been partly due to a minor fault of engine design which possibly became aggravated by the excessive strains imposed on the engine. Just under the blow-torch there was a brass plug. Now, cast-iron and brass do not expand and contract equally; consequently, when they got hot something had to go—that something happened to be the cylinder heads! Therefore, the owners dispensed with the brass plugs, since when there have been no more cracks.

What perhaps may be termed—if we stretch a point—another little weakness in the engine-design, which no doubt the heavy-duty imposed upon it brought to light, and which otherwise may never have caused any bother was the roller thrust, which takes the place of an ordinary thrust-block. The rollers are in two halves with brass liners inside. These proved too light for this job and wore out quickly, with the result that the engine main-bearings got hot and the white metal ran. The engine happens to be of the enclosed design, and the ship's engineers have some little difficulty in feeling the bearings.

Some delays at sea also were due to other minor incidents, such as hot crank-pins; hot gudgeon-pins; dirt and water in the oil-fuel; cleaning carbon from the cylinders and pistons. Little troubles also occurred with the steam-dynamo, but such did not delay the ship, because there is a spare oil-motor dynamo.

The engineer question also has given the owners considerable worry, and while we can sympathize with them in a sense, it must be confessed that the motor-engineer question has not been tackled by owners in general in America as thoroughly as it might have been.

There are in the United States today no fewer than 150 motorships in service or under construction of over 100 ft. length; but, as yet not a single attempt has been made by a combination of shipowners to establish a proper training motorship, as has been done privately by shipowners of several European countries, where boys can be apprenticed under written agreements, and afterwards made motor engineers. The success of the two existing American steamship schools, which have not one-quarter of the capacity of the demand should be an incentive.

In this way sufficient good engineers perhaps could be produced in several years to make a surfeit of trained marine-motor mechanics. Yet Motorship's efforts to have built such a training vessel have not received the slightest recognition or support from a single shipowner. More and more motorships will be built, as shipowners can't get away from their economy and advantages, and they eventually must have them whether they now want them or not, just as they were obliged to overcome their prejudice and turn to steam power years ago. Thus, they may as well train lads and men now and save themselves a lot of bother later on. Let some of our leading shipowners and oil-companies put their heads together and do something quickly. Then they won't grumble about the engineer scarcity.

However, the present owners of the "Starlite" are perfectly willing to hire and retain as long as they receive conscientious service, all the motor-engineers they can place; but, at present find that the men won't stay on board long enough to become familiar with the engine. Consequently these owners find that they are paying men who just go down to the ship and look the job over. This type of man generally decides that the job is too big for him, or that he is too good for the job. This would indicate that our training ship plan is a much needed one.

What has been the situation up to now? Instead of doing something tangible to solve the problem, a few shipowners—the present instance

(Continued on Page 16)

Scottish Shipbuilder's View of the Marine Oil-Engined Ships

It perhaps is unfortunate that such comparison figures should have been quoted as were made by Mr. Alexander Cleghorn, the new president of the Institution of Engineers and Shipbuilders in Scotland, in his presidential address on October 23rd last, when he dealt with the development of the various classes of ship's propelling machinery. We can only come to the conclusion that the tremendous pressure of work caused by urgent war productions has prevented President Cleghorn making a deep and discriminating study of the motorship question in its latest form, and that he has relied upon assumed figures rather than upon figures taken from records of up-to-date Diesel vessels now in service.

This apparently being the case, it would have been better had he omitted all comparison data from his address, because his figures we cannot agree with as they tend to be misleading. Coming from a shipbuilder of his high standing they are likely to have a very derogatory influence upon the progress of the large marine oil engine.

In the interests of progress of science and engineering, and of the development of the marine oil-engine we are reprinting the section of President Cleghorn's address dealing with the oil-engined ship, together with some comments as follows:

"No summary of recent progress in the mercantile service could fail to include the advent of the oil-engined ship made possible by the gradual evolution of the Diesel type of engine. A considerable amount of experience has now been gained, and in the cargo boat to which its application is still limited it has demonstrated many advantages and perhaps disclosed a few faults. The problem, again, is that of the relation between coal and oil in supply and price. In particular cases, with fixed routes, the oil may be available; but the oil engine could scarcely yet be considered a suitable equipment for a freight ship with a roving commission. Apart from the necessity of available supply, the oil-engine is not yet so developed that it can use any kind of oil.

"At the time of its original projection into marine work, it had to meet only the reciprocating steam engine with its heavy machinery and consumption of anything over 1.5 lbs. of coal per horse-power per hour. It was, therefore, easy to demonstrate its advantages in comparison therewith, but with the development of the highly efficient turbine gear-drive this demonstration becomes of greater difficulty. Again, the employment of the oil-engine is at a certain sacrifice of propulsive efficiency, as the revolutions at which it is run are not quite suitable for the slow-speed ship. Of course, geared transmission could be used as for the turbine, but this entails added weight, with a consequent reduction of its advantages. The hydraulic type of transmission would also seem to be quite applicable, and has been used in this connection.

"As an example for comparison, take a ship fitted with a 2,000 b. h. p. motor, assumed to be bunkered for a 20-day voyage with a few days' reserve of fuel and, alternatively, fitted with double-geared-superheat turbines of much lower propeller revolutions and, consequently, of lower shaft horse power. The gain in machinery weights would be a very small amount in favor of the oil ship—about 10 tons, but the difference in fuel weights would be much larger—about 490 tons of coal, against 250 tons of oil. The total increase in carrying capacity is therefore about 250 tons; and when other minor differences are allowed for, such as wages bills and the costs of lubricating-oil and stores, there would be a gain per voyage of about £150 for the motorship between the respective costs of fuel. The relationship between the respective costs of fuel per ton is, therefore, fixed, if the same overall economy is to be attained in each ship, and is approximately—for coal at £1 per ton oil must cost not more than £2 10s per ton. If, however, the oil ship were bunkered for the round voyage in place of the half voyage only necessary for the steamer, the gain from additional cargo would hold only on the half voyage, and in this case the oil should not cost more than £2 5s per ton.

"These figures are, of course only approximate. The question is further complicated by the relative first cost of the ships, depreciation allowances, repair bills, and the respective periods necessary in dock for repairs; but it will be seen that the two types of machinery may not be unevenly matched on the whole—except, perhaps, as regards running troubles, of which the oil-engine still possesses its full share. No doubt these difficulties will be overcome in time, and under the progressive policy which is being pursued by the British Marine Oil-Engine Manufacturers' Association, rapid development may be expected. Progress, however, up till now, has been slow, and it must be accepted as the present condition that, even in those cases to which the Diesel engine is particularly applicable, it is on no more than an equal footing with the modern steam plant."

President Cleghorn refers to the sacrifice of propulsive efficiency due to the higher-speed revolutions of the Diesel engine. This loss of propulsive efficiency fallacy we dealt with in a satisfactory manner in our last issue so need not comment further upon it here.

We will straight-away deal with the comparative weights, consumptions, capacities, and operating costs quoted in his address. In order that our figures may be as accurate as possible we will take for the purpose a well-known European four-cycle marine Diesel engine which is to be built both in England and America under license, of which we have the authentic data, both of the engine and of similar motorships in service. We certainly would like to know more about the Diesel ship whence Mr. Cleghorn received his basic figures.

ALEXANDER CLEGHORN

The New President of the Institution of Engineers and Shipbuilders In Scotland

Two-thousand brake horse-power is the power quoted by Mr. Cleghorn. A 2000 b. h. p. Diesel engine of this make will have a weight, with compressor and flywheel, of about 250 tons, and a full-power revolution speed of 100 r. p. m. We assume that the engine-room auxiliaries will be Diesel-electric-driven. The weight of these auxiliaries will be about equivalent to the weight of the auxiliaries of the turbine steamship. If, in the case of the turbine ship, lower shaft horse power be fitted (as quoted by Mr. Cleghorn) then the average annual speed of the ship would be less, as we have to assume the hulls have identical dimensions.

Now, the Diesel ship dispenses with the weight of boilers, condenser, tanks of fresh boiler water, (about 125 tons), water-in-the boilers, lighter shafting and propeller, funnel, etc., and so the total saving of machinery weight effected by the motorship will not be less than 175 tons, whereas Mr. Cleghorn claims the amount to be only 10 tons. This certainly is a difference worth considering!

We are also inclined to think that Mr. Cleghorn has got confused between indicated and brake horse-powers, as he quotes a 2,000 brake horse-power Diesel engine and we all know that it is customary to refer to marine steam plants in indicated horse-power terms. His consumption figures also are entirely different from actual consumption, as he makes his Diesel ship consume well over half the weight of oil that the turbine ship uses coal, which, of course, is not correct. So we will presently quote the real consumption figures respectively, and we will be over-fair to the coal burner.

A 2,000 b. h. p. Diesel engine of the make referred to by us will have an output of 2,600 i. h. p., which will be equivalent to the 2,450 i. h. p. of a steam plant. (We will not count the loss in efficiency due to the gear-reduction necessary for the turbine, as we can afford to be generous.)

Thus, for Mr. Cleghorn's ships we have a turbine of 2450 steam i. h. p., compared with an oil-engine of 2,600 Diesel i. h. p. having a fuel consumption at sea of not exceeding 0.30 lbs. of crude oil-fuel including for auxiliaries.

This gives a daily consumption (24 hours) of 29½ tons of coal and 8⅓ tons of oil respectively (2240 lbs=1 ton). This is a striking difference to the fuel consumption ratios quoted by Mr. Cleghorn!

We will take Mr. Cleghorn's argument of a 10 days one-way voyage for the steamer and a 20 days (at sea) round voyage for the motorship, making each carry a sufficient fuel for use at sea.

This means an actual consumption at sea of 295 tons of coal and 166 tons of oil-fuel, respectively, which gives an extra cargo capacity to the motorship of 129 tons, to which must be added the machinery and water-weight saving of 175 tons, affording a total cargo-carrying gain of 304 tons to the Diesel-driven vessel. If the voyages are longer the gain will be proportionately larger.

What this amount of cargo-carrying capacity is worth, of course, will vary with the class of cargo and the current rates, and shipowners can judge for themselves its value. But, if Mr. Cleghorn's turbine ship was oil-fired and had to carry (like the motorship) sufficient fuel for the 20 days round voyage, the consumption would be reduced a little, but the fuel consumption at sea would have to be increased to 590 tons, making a total cargo capacity in favor of the motorship of 424 tons. This, Mr. Cleghorn omits to mention, and what's fair for one is fair for the other.

These figures tend to upset Mr. Cleghorn's contention that the oil-fuel of a motorship must not exceed £2 10s ($12.50) per ton if coal be £1 ($5.00) per ton.

With coal and oil at these prices the fuel-bill of these respective ships on a 20 days' round voyage at sea, will be:

Turbine ship—590 tons coal at £1.0	£590
Diesel ship—166 tons oil at £2.10	£415
	£175

$875 in favor of the motorship.

We have not included the port consumptions which are greatly in favor of the motorship. Also the absence of stokers, and their keep, today will run into a saving of about £2,000 ($10,000.00) per annum for an American ship or about half that amount in the case of a British ship. This item Mr. Cleghorn overlooks! Nor have we included the time saved in bunkering.

In referring to the running troubles and repairs of oil-engines, Mr. Cleghorn evidently falls into a common error of omitting discrimination and of classifying early and later motorships as a whole, and makes no allowance for the fact that many of the earliest motorships (some of which are still running) were built under conditions that promised trouble and breakdowns before the Diesel engines ever left the builders' test shops. We have authentic records (as past issues of "Motorship" will demonstrate) of big Diesel ships that have maintained better services than the average steamer, and with smaller repair bills. Records published in past issues of "Motorship" will verify our oil-engine consumption figures.

Mr. Cleghorn also mentioned in his address that the Fottinger system of hydraulic transmission would seem to offer an appropriate reducing system for oil-engine work, the form being that of a highly flexible coupling which can easily be arranged for reversing, thus allowing the engine to be simplified.

It is our contention, however, that the use of transformers or any form of reduction gears do not form the right lines of development to follow, as, at their best they only become a subterfuge. Nothing that will impair the wonderful efficiency of the Diesel engine should be the aim of marine engineers, who should strive their utmost to make even greater developments with the direct-reversible, direct-coupled, oil-engine. Let us aim at

perfecting the oil-engine rather than use an intermediate means.

In the commencement of the foregoing section of Mr. Cleghorn's address he refers to the gradual evolutions of the Diesel type of oil-engine. We, however would term it as extraordinary rapid evolution, seeing that eight years ago there was not such a thing as an ocean-going Diesel-driven ship in service, and today there are several hundred. Only the war prevented their number being doubled. The evolution has been about six times as rapid as that of the marine steam engine.

Next, let us add (in directly opposite to Mr. Cleghorn's beliefs) that the oil-engine is a suitable equipment for a freight-ship with a roving commission because 1,000 tons of crude-oil in the double bottoms of a four-cycle motor cargo-ship of 8,000 tons carrying capacity and of 11 knots loaded speed, will carry her about 30,000 to 32,000 sea-miles or approximately 120 days "steaming" at full speed, and without effecting her regular cargo-carrying capacity.

Almost any kind of oil fuel can be used by a good marine Diesel oil-engine; but, the heavier and dirtier the oil, the more work there will be for the ship's engineers. So it is best to use if possible a fairly clean residual-oil, such as Navy fuel, or solar oil. However, if there is any marked difference in the price or supply of available oils where the ships call, the heavier oil may be used as fuel. For instance, mineral oil containing about 25 per cent asphaltum and 2 per cent sulphur can be used with but little trouble; but, it must be make fluid enough to follow the stroke of the fuel pump and to flow along the small feed-pipes, and water must be kept out of the oil, otherwise the sulphur will have ill effects. The use of a lighter residual fuel for about 30 minutes daily will clean the cylinders, pistons and valves.

Finally, we will comment upon Mr. Cleghorn's remark that the application of the Diesel engine is limited to the cargo-boat, which makes us inquire of him if he is not aware of what type of engine is successfully propelling the German and hundreds of other submarines, also many other classes of naval craft? Is it not the wonderful efficiency and reliability of the Diesel engines of the U-boats that has rendered possible a demoralization of the world's maritime commerce? To our comments it is to be hoped President Cleghorn will fully reply, and space in our columns is welcome to him.

OUR OIL-FUEL EXPORTS.

No more striking evidence could be obtained of the shortage of tankships, due to sinking by German submarines, than the following oil export figures taken from the Official Bulletin of Washington, D. C., for Sept. 14, 1917. There was a reduction in the total amount of oils of all kinds shipped this July compared with July of last year of 111,829,895 gallons. This, of course, is enormous and is most serious for the Allies, whose need for fuel and lubricating oil increases weekly. It behooves us to get busy building motor-driven tankers with all possible speed, because motor tankships will carry considerably more oil on a given tonnage, and consume much less oil themselves, also are more likely to get past the submarines unseen.

MOTORSHIP CONSTRUCTION IN ITALY.

The Savoia shipyard of the great Ansaldo Company are building vessels with Sulzer-Diesel engines, the latter being built under license from Sulzer Freres of Switzerland. As the Ansaldo Co., are associated with the Fiat San Giorgio there should be many opportunities of co-operation to the benefit of the development of high-powered marine Diesel engines, both merchant and naval types. Other Italian firms building motorships or marine Diesel engines are Franco Tosi, the Fiat san Giorgio, Paolo Kind, and the Savoia Shipbuilding Co.

OUR NAVY.

There now are under construction for the U. S. Navy no fewer than 787 vessels ranging from motor patrol boats to battle-cruisers.

AUXILIARY SCHOONER "PUSEY JONES NO. 4"

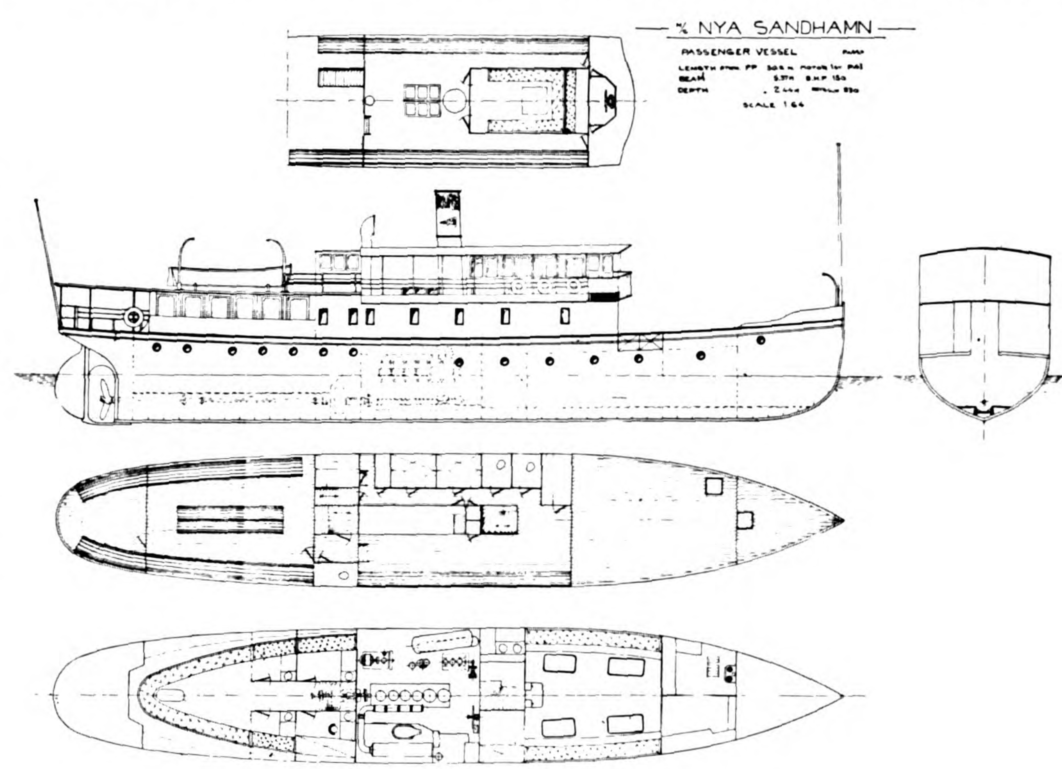
There has been classed 100 A-1 at Lloyds the three-masted steel-built auxiliary schooner "Pusey Jones No. 4," a ship of 398 tons built in 1917 for T. O. Hannevig by Pusey & Jones of Wilmington, Del., and fitted with two Avance 13¾" bore by 16½" stroke Avance surface-ignition type marine oil-engines. Her length is 129 ft. by 28 ft. breadth and 13 ft. depth.

Another Steamship Converted to Motor Power

In Europe the marine-oil-engine has been widely adopted because of economic-pressure, crude-oil being comparatively expensive, even in normal times, when we consider what steamship owners of this country have been paying for bunker oil-fuel. Consequently it is not surprising to find that many European owners when deciding to change from coal to oil-fuel have not contented with that of her previous steam machinery. An additional economy is gained by reason of the absence of stand-by fuel charges in the intervals between the daily trips made by the "Nya Sandhamn." Also the smaller space occupied by oil-engines increases the carrying powers of the ship by reason of more passenger accommodation being available.

THE "NYA SANDHAMM"

themselves with merely altering the boilers from coal furnaces to oil-firing; but have removed the entire steam machinery and replaced the same with the internal-combustion-crude-oil motors. By this means they not only have increased the cargo



PROFILE, DECK PLAN AND GENERAL ARRANGEMENT OF M. S. "NYA SANDHAMM"

carrying capacity of the ship by 10 or more per cent, but have effected a great economy in the fuel consumption and have dispensed with stokers. Whereas, had they merely changed the firing of the boilers from coal to oil they would have increased the carrying capacity of the ship by no more than one or two per cent, and would have only reduced the fuel consumption from about 1.30 lb. per 1 h. p. hour to about 1.00 lb. per 1 h. p. hour. This can be compared with about 0.30 lb. per 1 h. p. hour for the motorship.

Among steamers recently converted is the "Nya Sandhamn," a Swedish passenger vessel owned by the Rederiaktiebolaget Sandhamn-Stockholm. Before the conversion to motor power the owners were obliged to curtail the service to what was absolutely necessary owing to the scarcity of fuel. But now they are enabled to keep the traffic in normal operation because of the economy of her present Diesel-engines in comparison

The ship is 99' long, by 17½' beam and 8' depth; and her new machinery consists of a Polar direct-reversible crude-oil motor of the two-cycle Diesel-type, built by the Aktiebolaget Atlas Diesels Motorer, of Stockholm, whose U. S. A. constructional licensees are the McIntosh & Seymour Corporation of Auburn, N. Y. This engine develops 150 b. h. p. at 230 r. p. m., and is different in design from the four-cycle type Diesel engine built by the American licensees. There are four working cylinders, and at the forward end there are two maneuvering cylinders, which are used as scavenging pumps as well as for air-starting and reversing. An extension of the piston of one of these pumps forms the air-compressor for injection of fuel.

She was placed in commission in the spring of 1916, and her owners have found her to give very satisfactory results. She has been running in the Stockholm archipelago, which traffic has put both the ship and engines to a severe test. During the daily trips the "Nya Sandhamn" has had to put in at a great number of landing stages, and so far her engine never has failed to properly maneuver.

An Interesting Letter from China

Two and Four-Cycle Diesel Engines

MR. HAROLD B. WILSON, the writer of the following letter, is the engineer in charge of the largest stationary Diesel engine in China. It is interesting, for it comes from a man who, although not a marine engineer, nevertheless has had exceptional opportunities to study the Diesel engine from many angles.

Canton, Sept. 28, 1917.

"Motorship," Seattle, Wash., U. S. A.

Gentlemen—A copy of your publication of June, 1917, has come to my hands, and I note with interest, an article on page 22, entitled "Diesel Experts."

Engine builders the world over have learned by sad experience that the Diesel engine is not merely an enlargement of the gasoline motor. Some experts seem to draw their conclusions as to the merits of the two and four cycle types from their experience with vaporizer engines. This is not true of the majority of experts, for both the two and four cycle Diesel and surface-ignition engines have friends among the best of combustion engineers, and their articles are based on actual experience.

In view of the miraculous success which has attended even the first installations, it is ridiculous to discount the Diesel engine for marine propulsion. True, we hear some sad stories now and then, but the writer will cite one instance for your critic, though the subject is a heavy, slow-speed type. The motorship "Vulcanus," mother of Diesel-engined ships, put into Canton a month ago, and it was the writer's pleasure to go aboard to inspect the engine. The chief engineer reported a six week's voyage without mishap. This vessel has been in the Far Eastern oil trade for several years, having been launched in 1910, and if her reliable performance is to be taken as an indication, the new ships will certainly do as well if not better.

The tendency seems to be growing toward the two-cycle type for large units, and the Krupp interests, prior to the war were building engines of the four-cycle type up to 300 h. p. only; higher powers were of the two-cycle type. The writer talked with one of the oldest four-cycle Diesel engineers in America about a year ago, at which time he was working on a two-cycle, double-acting engine. This is not the only instance in America. Several of the large stationary engine manufacturers have discontinued their large units in the four-cycle type in favor of the two-cycle, and one prominent manufacturer of four-cycle marine and stationary engines on the Pacific coast is agent for a new but promising two-cycle engine built in the East. This amounts to nothing more or less than an admission of the superiority of the two-cycle.

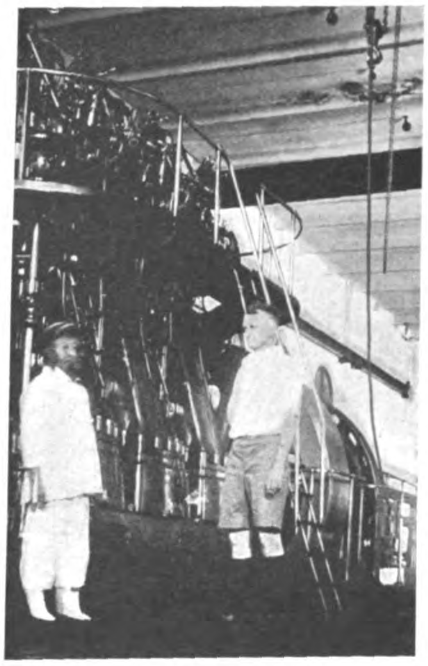
The writer is not a marine-engineer; but, for a cub, has had exceptional opportunity for the study of Diesel engines. He has been through the experimental and development work of two different types of two-cycle engines, covering a period of two years. For the past year, he has been mechanical engineer in a power-plant containing nine four-cycle Diesel engines, ranging in power from 200 to 500 h. p. of five different makes representing the best European and American practice.

From his experience, the writer is a booster of the Junker's type of two-cycle engine, and cannot understand why this engine has not met with more favor from engine builders. It may be operated at higher speeds than other types of similar dimensions due to the almost perfect running balance. Each of the pistons takes up half of the total stroke, thereby making the piston speed only half of that of the conventional type of similar stroke. Each piston head may be concave, so that the combustion space approaches the ideal sphere. No mechanical scavenging valves are required as the upper pistons uncover the exhaust-ports, while the lower pistons uncover the scavenge-ports. For stationary engines the scavenge ports open before, and close after the exhaust ports without the aid of a mechanically operated valve, and for marine engines, a mechanically operated vaive could be applied and used for reversing, or operating in reverse rotation. The force of the expansion is exerted against the two pistons and transmitted to the crankshaft in opposite directions, so that the cylinder castings may be much lighter than in other types.

Some engineers are imbued with the idea that a Junker's type of engine stands much higher than engines of similar power of other types. A Junker's type of the same bore and stroke of the "Neptune" engine described in your June, 1917, issue, could be built four feet shorter.

Now, as to the relative merits of the Diesel or high pressure engine and the semi-Diesel or low pressure type, the greater simplicity of the latter will probably always make it more popular than the former in the smaller sizes, say up to 200 h. p. However, there is much to be said in favor of the Diesel even in the smaller sizes. Semi-Diesel or low pressure engine builders, one and all, have found it necessary to use semi-steel for cylinder castings, and some are using a semi-steel piston also, while a good grade of close grained grey iron seems to be good enough for the Diesel engine.

In fact, in our station, we are using cylinder liners which were made in a local Chinese foundry. This foundry is without the aid of a chemist, metallurgical engineer, or expert supervision, and their product is therefore of rather poor quality. In fact the iron used is from a No. 3 black India pig. Semi-steel cylinder castings came into use when the hot-bulb engines were fitted with the water-drip or water injection, which caused excessive wear on the cylinders. Those who have discontinued the water-drip probably have not tried grey iron castings since making the change.



H. B. WILSON

Part of a 500 h. p. 3-cylinder, 180 r. p. m., Lyons-Atlas, four-cycle Diesel engine, direct connected to a 2200 volt 3-phase, 60 cylinder General Electric alternator with direct connected exciter and three-stage Ingersoll-Rand compressor.

Cracked cylinder heads are a common source of trouble among certain semi-Diesel engines. In our station, only one size of cylinder, 21"x30", has given us any trouble in this respect, and we believe we have found the cause and remedy. Some of the semi-Diesel manufacturers have also found the cause and remedy.

Semi-Diesel or low pressure engines require six cubic feet piston displacement (power strokes) per brake horsepower, while most Diesel engine builders rate their machines at three cubic feet or a trifle more. This means that you get twice the power output per bore and stroke in the Diesel engine, and some buyers are willing to accept the few more complications of the latter and obtain the greater fuel economy.

A feature in favor of all two-cycle, single-acting engines is that the stresses are always in the same direction, while in the four-cycle engine the suction stroke causes a reversal of stress. In large engines where very heavy pistons are used, this tends to loosen up the bearings and cause them to pound. Pounding may occur when it is inconvenient to shut down and repair the damage, and neglect of this pounding will cause the wrist pin to loosen up in the piston or crosshead. Continual pounding tends to produce crystallization of the wrist pins, crank shaft and crank pin bearing bolts. This feature caused one of the worst accidents that has occurred in our plant. A wrist pin bearing bolt gave way, freeing the connecting-rod, which jammed in the crank case and brought the engine to a dead stop. The crankshaft was twisted through an angle of 180 degrees, without breaking, and one piston and liner got smashed up badly. This accident might have been avoided had the bolts been removed and annealed every six months or so. In large sizes where pistons of great weight are used, this idle stroke sometimes causes the piston pin to loosen up in the piston and a new pin must be made or the old one refitted.

Dropping of valves into the cylinder is an occasional trouble in the four-cycle type of engine. This trouble makes itself evident when engine is running at full load generally, and when a shut-down to clean out the broken parts of the valve and refit a new valve and cage is a decided inconvenience to customers. A shut-down at sea on account of the same trouble may prove disastrous.

Yours very truly,

HAROLD B. WILSON.

[Judging from Mr. Wilson's fourth paragraph he infers that the successful old veteran motorship "Vulcanus" is equipped with two-cycle type engines. As a matter of fact they are Werkspoor four-cycle type Diesel motors. There also is another error in the same paragraph, as no American oil-engine builder has discarded the four-cycle engine in favor of the two-cycle, although two U. S. A. companies building two-cycle engines have taken up the four-cycle marine Diesel engine.

Mr. Wilson also says that one prominent Pacific Coast four-cycle engine manufacturer has taken up an Eastern two-cycle engine, which amounts to an admission of the superiority of the two-cycle engine. However, we may mention that the construction of the latter engine is being abandoned by the Eastern builders in question so we presume that the Pacific Coast agency will fall through. "Motorship" is not prejudiced in favor of any type of engine; but we desire to keep our readers informed of the facts as they are.

Why the Junkers marine engine has not been largely developed is because there is not a single case of its success at sea under ordinary maritime conditions in sizes over 300 b. h. p. and where merchant ships have been fitted with Junkers engines the results have been very disappointing, and we refer Mr. Wilson to pages 12 to 14 of our June, 1917, issue, which he had before him at the time of writing to us. We hope that the Junkers engine eventually will be successfully developed. Mr. Wilson, who is in charge of stationary Diesel engines, perhaps does not fully appreciate the great difference between running an engine on land, and under average ocean-going conditions. Regarding valve-troubles with four-cycle type engines at sea, the majority of builders have now been enabled to eliminate these troubles and so they are practically a thing of the past with all modern four-cycle Diesel engines.—Editor.]

THE SULZER TYPE OF DIESEL ENGINE.

To the Editor of Motorship:

Dear Sir—Quite a number of great engineering companies have paid some attention to the Sulzer-design of marine Diesel engine, although in some cases they already had their own design of Diesel motor.

For instance, the two 600 b. h. p. Nobel engines of the M. S. "Imporatriza Alexandra" are distinctly based on Sulzer design, as seem to be the Fiat motors of the M. S. "Ceara." In the latter case it is said that Ansaldo & Co. are the controllers of the Fiat-San-Giorgio, Ltd., and it is Ansaldos who have purchased a Sulzer license. It also is said that the Soromows Works and the Kolomna Works, both of Russia, have bought Sulzer rights, as have the Busch-Sulzer Co., of St. Louis, Mo. In Spain the Sociedad Espanola de Construccione Metalicas has purchased a Sulzer license as also has a large French shipbuilding company. This looks as if something interesting may shortly be expected from the Sulzer engine, and that developments should be watched.

Yours faithfully,

J. P. H.

M. S. "MONTE PENEDO" NOW NAMED "SABARA."

The motorship "Monte Penedo," recently owned by the Hamburg-South America line and taken over by the Brazilian Government, has been renamed "Sabara."

British Diesel-Driven Naval Tankers

Nine Motorships Were Ordered by the British Admiralty Before the War and Since That Time They Have Requistioned Twelve Others

IN March of 1913 Mr. Winston S. Churchill, then first Lord of the British Admiralty, said before the House of Commons:

"We are not very far, we cannot tell how far, from some form of internal-combustion-engine for warships of all kinds, and the indirect and wasteful use of oil to generate steam will, in the future, give place to the direct employment of its own force."

So it is not surprising that during his term of office considerable progress was made by the British Admiralty with the development of the marine crude-oil engine, and many big motorships were ordered. It is not generally known in this country that in 1913 Vickers, Ltd., the great British naval shipbuilders and engineers, ran exhaustive trials with a single-cylinder Diesel engine of 1,000 b. h. p. for the British Admiralty.

Before the war, British Admiralty announcements showed that no fewer than nine (9) Diesel-driven bulk-oil carrying tankships had been ordered by them from the Royal dockyards and from private shipyards. Various makes of two and four-cycle Diesel-type engines were built for these ships. It also was said that Burmeister & Wain of Copenhagen received an order from them for a four-cycle type Diesel-engine, for this purpose and, if this is correct, there were a total of ten motorships ordered at that time. Of course, no details of tankers ordered by the Admiralty since the war have been given out; but, it can be assumed that the Diesel engine has not been neglected by them for later vessels. The names of the motor-driven tankships ordered previous to the war are:

Name—	Horsepower.	Tonnage.
H. M. S. "Olivia"	......3,200 b.h.p.	8,000 tons d.w.c.
H. M. S. "Olaf"	........3,200 b.h.p.	8,000 tons d.w.c.
H. M. S. "Oloa"	.......3,200 b.h.p.	8,000 tons d.w.c.
H. M. S. "Turmoil"	.....1,600 b.h.p.	2,000 tons d.w.c.
H. M. S. "Trefoil"	......1,500 b.h.p.	2,000 tons d.w.c.
H. M. S. "Servitor"	....	8,000 tons d.w.c.
H. M. S. "Ferrol"	...... 450 b.h.p.	1,000 tons d.w.c.
H. M. S. "Carrol"	...... 450 b.h.p.	1,000 tons d.w.c.
H. M. S. "Olympia"	....	....

In giving these details we are revealing no information likely to be of naval or military importance, because we know for certain that all the details in this article reached Germany before the war, and some of the Diesel-engines of these ships actually were designed or partly designed in Germany by German marine-engineers who at the same time were engaged on naval work for their own country. But, the information will enable American shipowners and shipbuilders to see that the British Admiralty recognized the value and importance of the marine oil engine. After the Dardanelles affair, many of us have been inclined to look with doubt upon Mr. Churchill; but, there can be no doubt but that he is a far-sighted man, as shown by his connection with the development of the "tanks," and by the manner in which he foresaw the war and had the British fleet ready for action in ample time to save England from invasion. His attitude towards the marine internal-combustion-engine is another example of his foresight.

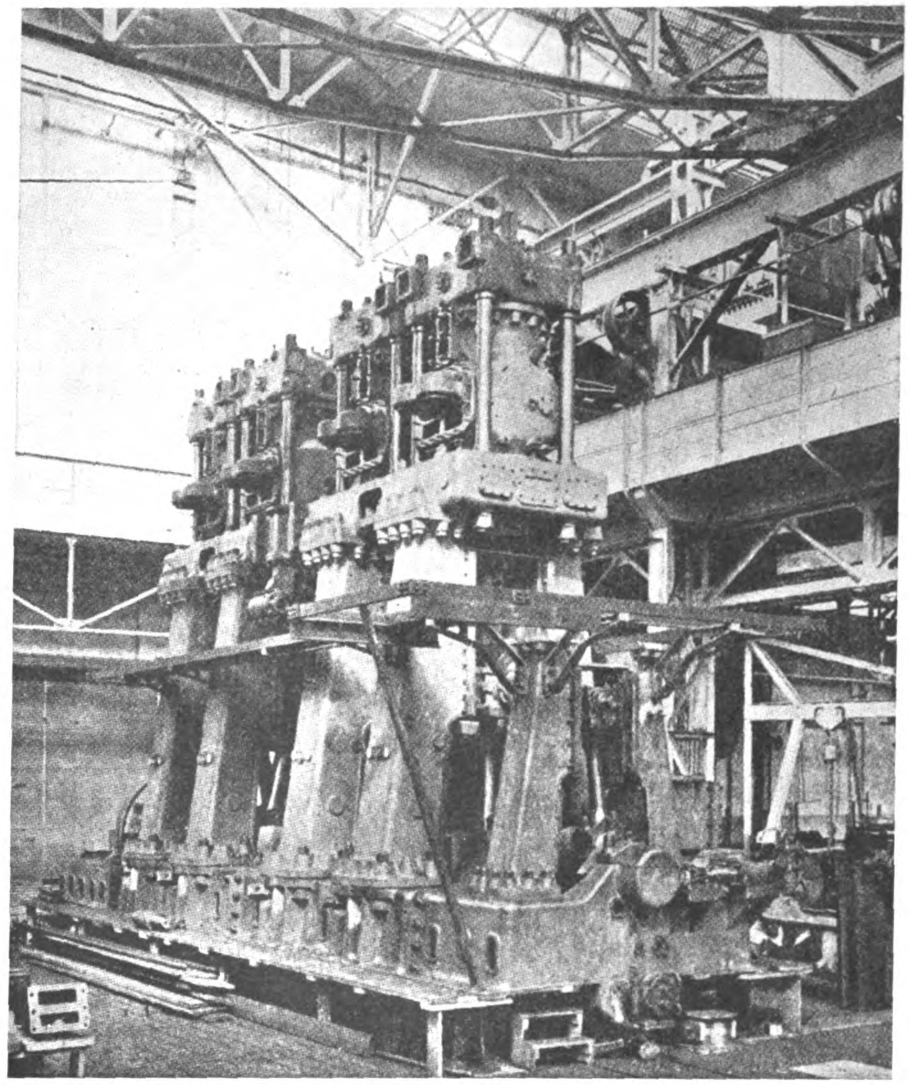
We give an illustration of the four-cylinder Sulzer port-scavenging, two-cycle type, 1,600 b. h. p. Diesel-engine at 150 r. p. m. of one of these Admiralty tankships, showing it in course of construction at Winterthur, Switzerland. For an engine operating on the two-stroke principle the fuel-consumption was very moderate, being 0.45 lb. per b. h. p.

The H. M. S. "Turmoil" was built at the Royal dockyard at Penbroke, Wales, and her Diesel engines were of modified German design, somewhat similar to those in the U. S. Diesel-driven tanker "Maumee," and were built under license by Messrs. J. S. White & Co., of Cowes, I. of W. They are of the M. A. N. two-cycle type and are of 800 b. h. p. each. The designed full-power speed of the ship was 12½ knots when loaded. She is 280 ft. long by 39 ft. beam and 23½ ft. molded depth.

The H. M. S. "Carrol" was built at the Devonport dockyard and was equipped with two 225 b. h. p. Diesel engines of the M. A. N. type, constructed under license from Nürnburg Maschinenfabrik by the Fairfield Co. of Govan, Scotland. These motors have six cylinders 9 inches bore by 13¾ inches stroke.

Two of the other ships had Vickers-Diesel engines installed, and one ship had two four-cylinder, 11¾-inch bore by 17 inches stroke; two-cycle type F. I. A. T.-Diesels, each of 225 b. h. p. at 200 r. p. m., built under license from the Fiat-San Giorgio, Ltd., of Italy, by Scotts Shipbuilding Co. of Grennock, Scotland. Also one vessel had two 1,600 b. h. p. Carels-Diesel engines built by Carels of Ghent, but no announcement has been made as to whether or not they were delivered before the Germans occupied Ghent. The first of the Diesel-driven tankers was launched at the Devonport Royal dockyard in 1913.

The "Trefoil" was also built at the Penbroke Royal dockyard, and is 280 ft. long by 39 ft. beam and has a dead-weight-capacity of 2,000 tons. She is propelled by two eight-cylinder 17-inch bore by 27-inch stroke Vickers four-cycle type Diesel oil-engines turning at 150 r. p. m., at which speed each develops 750 b. h. p., giving the ship a speed of 12 knots. She was launched in October, 1913. A feature of her engine is that no compressed-air is used for the injection of fuel, and direct pump (solid-injection system) being employed.



A FOUR-CYLINDER 1600 B. H. P. SULZER-DIESEL MARINE MOTOR NOW INSTALLED IN A BRITISH TANKSHIP

It recently was announced that the British Government had requisitioned the shares of the Royal Dutch Petroleum Co., which presumably will give them control of the twelve Werkspoor Diesel-driven tankships owned by subsidiaries of that great oil company. If such is the case the British Admiralty will at least have 21 Diesel ships all told.

More Skandia Expansion and Orders

AN indication of the rapid growth of the oil-engine industry on the Pacific Coast is shown in the Skandia Pacific Oil Engine Company of San Francisco, who have made and are making several large additions to their now extensive and well-equipped shops at Oakland. A new machine shop 350 feet long and 90 feet wide, a two-story office building finished in stucco, 30x60 feet, which houses the offices of the plant on the lower floor and the draughting rooms on the second floor, a large new pattern shop, and a steel and brass foundry are the new additions. To these will be added from time to time more buildings to accommodate the expansion that is anticipated with the placing of orders for the Werkspoor Diesel. The plant as it will be when these new buildings are completed will be 300% larger.

Some of the recent orders placed with this company are for three 240 h. p. sets for Christoffer Hannevig to be placed aboard ships on the East Coast, four 120 h. p. for the Columbia Engineering Company of Portland, Ore., for the same owner acting for Norwegian interests. Two auxiliary schooners of 2,400 tons, built after the plans of the Washington Shipping Corporation will be equipped with twin 240 h. p. Skandias and will also have Skandia auxiliaries. A duplication of this last order has been placed with the Matthews Shipbuilding Company of Grays Harbor for the Mons Isaksen Company. Other East coast orders are those for four 350 h. p. for Hannevig and two 55 h. p. engines for fishing boats. Two 55 h. p. engines were also sold to Southern California fishery operators.

This company is also preparing to build Werkspoor Diesels as shown by the making of patterns and other preliminary plans. These patterns are for the building of 6,500 h. p., for stock. For the next issue we are hopeful of obtaining for our readers more information regarding these last engines.

MOTORSHIPS AND THEIR OPERATION

(Continued from page 10)

excepted—have proceeded with the ordering of motor-vessels and serenely waited until their ships were ready for trials and then assumed surprise because capable marine motor-mechanics were not to be found "twiddling their thumbs" or the docks. Some shipowners selected intelligent marine-steam engineers and have sent them to the engine-builder's works during the final three months' construction and testing of the oil-engines of the ships that they ordered, in order that the engineers may be "brought up" with the machinery that they are to operate.

Some considerable time before each of these six vessels were delivered, the present owners of the "Starlite" sent registered motor engineers to the ship builder's works to help in the erecting, under the supervision of the engine-builder's erector, to thus become familiar with the engines. Other owners should follow this excellent example.

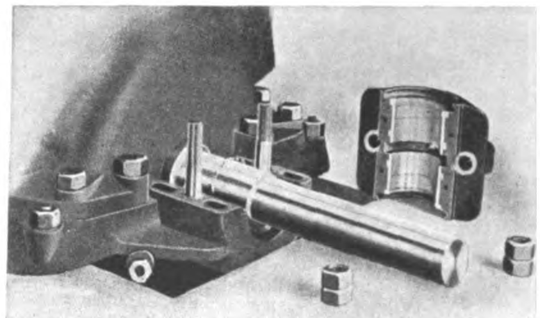
But, the matter really is serious, so that is why we are so frank in our remarks, and it is to the interests of all shipowners that we shall be frank about it.

Of course, shipowners always will suffer from "crooked" engineers whether steam or motor men. One very suspicious instance arose in connection with one of the sister-ships of the "Starlite," which we mention because it happened to have cast an entirely unwarranted slur upon the reliability of her oil-engine. This ship recently was held up for six weeks in a South American port, the chief-engineer having reported the crank-shaft bearings badly worn. A bill for $14,000 for the work of repairs was presented by a local firm of engineers. It afterwards transpired, somebody having "let on," that the bearings had only worn down the thickness of a piece of paper, so the whole delay and expense apparently was purely a piece of underhanded work arranged between the engineer and the local repair firm.

Still, it gives an inkling as to why so many shipowners unwittingly regard the motorship as unreliable luxury, instead of the pronounced success that it really is when properly designed, built and operated. In future, when reports of unreliable running of oil-engined motor-vessels reach the ears of shipowners, their motto should be—STOP, LOOK, INVESTIGATE!

A NEAT MAIN-BEARING DESIGN.

With some enclosed types of surface-ignition marine oil engines, the engineers-in-charge have experienced a little difficulty in feeling the main bearings when the engine is in operation, or in removing the bearings for examination and measuring purposes. The illustration given is of the neat main bearing design of the Hexa marine motor, a Swedish engine built by the Fritz Egnell Engineering Works, Stockholm, but almost unknown in this country.



MAIN BEARING CONSTRUCTION OF THE HEXA MOTOR

The bearings, it will be noticed, are outside the crankcase where they can be felt at all times, and the brasses, with their white metal liners, easily can be removed by detaching a pair of lock-nuts holding down the bearing block. On either side of the shaft are two broad tightening washers of gunmetal, the faces of which are provided with grooves. On one side they are kept tightly pressed against the crankshaft, and against the crankcase on the other side by means of springs. This eliminates all leakage of lubricating oil from the bearings, even though the washers may become worn after prolonged use. The bearings can be detached without moving the "tighteners" fitted between the bearing and the crankcase. In the center of each bearing is a chain lubricator which can be noticed in the illustration.

H. S. GRAY CO. SKANDIA HAWAIIAN AGENTS

The H. S. Gray Co., of Honolulu, have recently been appointed agents for the Skandia Pacific Oil Engine Co. in the Hawaiian Islands.

INFLUENCE OF THE WAR ON THE SUBMARINE POLICY

(Continued from page 8)

haust is distinctly audible for a long distance and characteristic in its quality. If the exhaust be arranged above the water line, it is directly audible. If an under-water exhaust be employed, the microphone of the listening plate on another vessel tells the story. From the two horns of that dilemma there appears to be no immediate escape, but it offers a promising field for ingenuity.

In stalking enemy submarines, either in the open or using a merchant ship as decoy, the element of chance naturally plays a conspicuous part. At least as much success will probably be attained when no decoy ship is used for the reason that the noise of the decoy's propellers will tend to obliterate the sound of the enemy's screws. An extensive zone of silence as complete as possible is really the desideratum, and all internal noise must be entirely eliminated. Under these conditions a sufficiently numerous fleet of submarine patrols in the theatre of operations would assuredly serve to cause the enemy some distraction other than the preoccupation of hunting down merchant ships, and this fact alone, not to mention its undoubted undermining effect on the enemy's morale, would justify its raison d'etre.

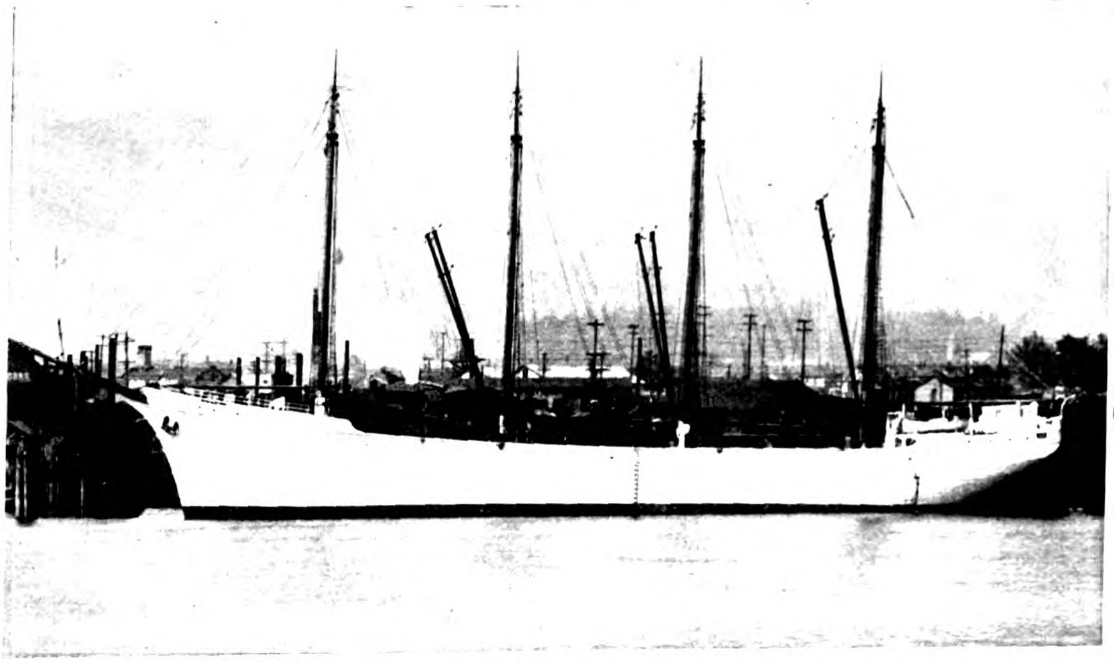
NEW SWEDISH 9,000 TON MOTORSHIPS.

Now under construction at Gothenburg, Sweden, are a number of large steel-built, Diesel-driven, twin-screw motorships to the order of the Transatlantic company, and the first of these vessels is completed and shortly will run her trials. Her engines, which are of the four-cycle type, were built in Sweden under Burmeister & Wain license, and are of 1,000 shaft horse-power each. It is reported, by the way, that Burmeister & Wain of Copenhagen, Denmark, have discovered a means to run their Diesel engines on peat-gas, thus avoiding the use of heavy oil for land power purposes.

ANOTHER CONCRETE MOTORVESSEL.

At Porgrunds Cementstoperi, there is under construction a 200-ton concrete motor lighter to the order of the Bjaalands Laeter Kompani of Skein An 80 h. p. Bolinder oil engine will be installed.

The Mishap to the "Astri"



MOTOR AUXILIARY "ASTRI"

THE "Astri" encountered a gale off Mazatlan on the Mexican Coast while on the way from the Columbia River to Valparaiso, and as a result came near being lost. The hurricane strained the seams of the vessel to such an extent that she became half full of water. Her engines were stopped and as the ship was water-logged and because her sails were not sufficient to propel her she drifted gradually ashore. When about six miles from shore the lead showed fifteen fathoms. The captain ordered the anchors down. They held and then all hands were put to the pumps. For three days and nights they worked the hand-pumps. Finally the engine room became free of water and the crew was put to work cleaning the engines. At the end of the third day one of the engines was in shape to run and the ship was headed north and in five days time she arrived at San Diego, still leaking badly, and her crew exhausted by their hard labors. Temporary repairs were made there and then she proceeded to San Francisco, where she is now under repair. She carried 1,547,000 feet of lumber and during the storm she lost all of this but 150,000 feet.

The "Astri" is 266 feet over all and 246 feet on the keel. Her beam is 43 feet and depth 22 feet. She has a gross tonnage of 1,780, with a net tonnage of 1,358. Two 320 b. h. p. Bolinder engines furnish her power and it is a great tribute to these engines that the ship was saved and that these engines were able to withstand this severe test—under water for three days and then, after a hasty cleaning, bringing the vessel into port. Her auxiliary power is furnished by one 75 and one 15 h. p. Fairbanks-Morse engine.

A NEW MERGER.

Negotiations have about been completed for the absorption by the Pusey & Jones Co., of Wilmington, Delaware, of the Pennsylvania and New Jersey Shipbuilding Companies. A New York interest is supposed to control these companies and to represent a large investment of Norwegian capital. These companies are comparatively new enterprises, each being capitalized for $2,500,000. The properties of the three companies forming the merger are to be taken over by the new company at cost. Full details are not available, but the merger will be completed in a few days.

Christoffer Hannevig will be the president of the company and with him will be associated the following officers: Finn Hannevig, vice-president; H. E. Norbum, vice-president and treasurer, and manager of the manufacturing department; Henry Lysholm, vice-president and general manager of the shipbuilding plants, and R. N. Bullowa, secretary.

A NEW WESTINGHOUSE CATALOG OF INDUSTRIAL MOTORS.

The second of a series of catalogs of industrial motors has been distributed by the Westinghouse Electric and Manufacturing Co., of East Pittsburgh, Pa. It is known as catalog 30 and covers the company's complete line of direct current motors and generators for industrial service. After several pages devoted to general information regarding ordering, classification and selection of direct current motors there follows a complete description, rating and dimensions for type S K commutating-pole motors, reversing planer motors, type C D motors, headstock equipment for wood-working plants, type S K and C D motor generators and arc welding equipment. Much new information is given, especially on such subjects as arc welding, head stock equipment, and battery charging service. The new catalog is identical in size and will fit the binder for the company's line of catalogs covering supply apparatus and small motors.

THE BRITISH NAVY AT WAR.

In answer to the common queries: Where is the British Navy? What is it accomplishing? Why does it not get into action?, a new book entitled "The British Navy at War," by W. Macneile Dixon, Professor in the University of Glasgow, and published in the United States by the Houghton-Mifflin Company of Boston and New York, has just come off the press. It is as interesting as any book could be, and if anyone doubts the great scale of operations as carried on by the British Navy this book will soon rid him of them.

Bound in cloth and fully illustrated by photographs and maps, this book is well worth the price, which is $0.75 net. It may be obtained at this price from Motorship.

LAUNCHING OF THE M. A. "DIXMUDE."

The third of six auxiliary motor vessels building for the French Government at the Puget Sound Bridge and Dredging Company's yards at Seattle, Wash., was launched Dec. 12. She is a sister ship to the "Barleux" and "Douamont" and was christened the "Dixmude" by Mrs. K. M. Walker. The new craft went down the ways practically 100% completed, and after drydocking will be ready for her trial trip. The fourth of these vessels will be launched towards the end of December. They are all equipped with 250 h. p. Skandias.

SHIPPING BOARD COMMANDEERS THE "S. I. ALLARD" AND THE "PORTLAND."

The Chas. R. McCormick Company of San Francisco have received official notification that two of the ships belonging to the company have been commandeered by the United States Shipping Board and that they hold them for immediate use. They will be handed over to the Matson Company to be used in the San Francisco-Hawaiian trade about the first of the year. These two ships are of the very best and successful types built on the Pacific Coast. The plans of these vessels have been purchased by the British Government and a number of sister ships have been built to these plans by British Columbia shipyards. The "S. I. Allard" had several improvements that the "Portland" did not have, among these being the Herzog steering gear made in San Francisco.

M. A. "H. C. HANSON" REACHES CALLAO.

Fifty-one days from Puget Sound to Callao is the record of the M. A. "H. C. Hanson," which arrived at that port Dec. 17. This is a very creditable showing for the reason that half of the voyage was made under one engine—the supply of lubricating oil having depleted for some unnamed reason. The "H. C. Hanson" is the product of the Seaborn Shipbuilding Company of Tacoma, Wn., and is equipped with twin 240 h. p. Skandias.

After discharging her cargo at Callao she will proceed to Caleta Buena, Chile, to load nitrate for Honolulu or British Columbia.

SAILING-SHIPS AND SUBMARINES.

The Shipping Board had stopped the sailing to the war zone of all sailing-ships and auxiliary sailing-ships, because they are susceptible to submarine attack. Yet we must not forget that it was only a few months ago that the Government of France publicly honored the officers and crew of the French sailing-ship "Kleber" for having successfully destroyed a German submarine. The captain of the "Kleber" lost his life during the encounter, so that the medal was awarded to his widow.

Characteristics of Systems of Lubrication for Motorships

By THOMAS E. COLEMAN.

We commend the following frank and interesting article to the careful consideration of every reader of Motorship. As vice-president of the Madison-Kipp Lubricator Co., Mr. Coleman has availed himself very fully of the opportunity for making a detailed investigation of the problems of motorship lubrication. His observations are both timely and valuable.—The Editor.

THE source of pride or discomfort of a motorship's chief engineer is centered greatly in the wear of motor parts after a long voyage. For, if a motor displays no unreasonable wear after a number of weeks of service, he can be reasonably sure that he is using proper lubricating oil and correct means of oil distribution.

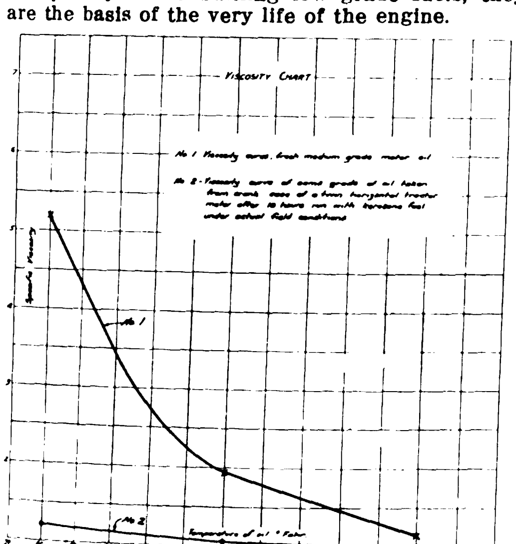
But, if wearing surfaces prove to be the cause of constant concern in spite of the use of good oil, he can be certain that the system of lubrication must be modified.

Some readers will no doubt protest at this point that the trouble may be located in the quality of the fuel used. This is quite true, but the question of fuel is one element to be reckoned with in the design of a lubricating system.

It would be interesting to have accurate statistics covering the causes of a number of unsatisfactory heavy duty marine motor installations. It is very probable that faulty lubrication would be the guilty factor in the vast majority of cases. And since we must admit that there have been a great number of unsatisfactory installations in the past few years, lubrication,—the guilty factor—should experience a rigid course of discipline.

If improvement in motor design is coming swiftly, as it should at this time, it seems cogent that designers must swallow the pill of abandoning their pet hobbies of oiling systems and trace their pens along lines suggested by cases of regrettable dissatisfaction. For lubrication has always had to undergo the painful operations of every man's ideas in all fields of motor development. A man often designs an engine, and then as an afterthought amends it with an oiling system. Very often it is different from anything else that has ever been tried,—anything to get oil to where it ought to be. Others spend a great amount of time on the oiling system, apparently for the purpose of inventing ingenious means of distributing oil, instead of directing their attention to the deep causes of trouble.

For there are fundamentals in lubrication that apply to every type of internal combustion motor built. They are more important in some cases than in others, but they are so vital that they cannot be ignored in any case. In the marine heavy duty motor burning low grade fuels, they are the basis of the very life of the engine.



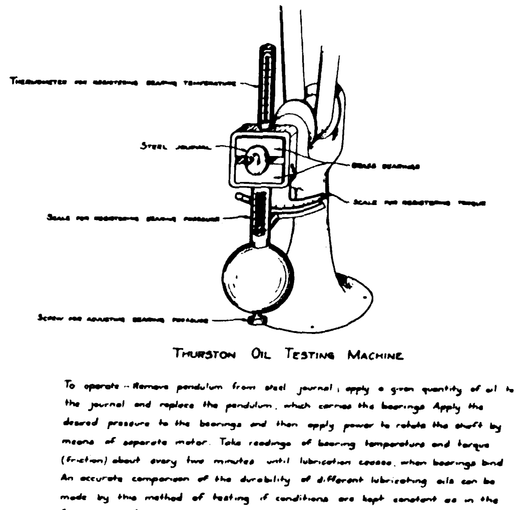
COMPARATIVE VISCOSITY CHART OF UNUSED AND USED LUBRICATING OIL

These fundamentals are concerned with (1) the quality of the lubricating oil; (2) its condition when applied to the cylinders and bearings; (3) the quality required for good results, and (4) the dependability of oil delivery.

When an engineer sets himself to work with these things firmly in mind and with the good intention to produce ideal conditions of lubrication, he may find that he is designing his motor to a lubricating system, rather than the popular reverse method. And may he not profitably do so, in view of the fact that any piece of machinery stands or falls on the basis of lubrication?

There is no intention to consider here the quality of lubricating oil that is best suited to the motorship engine. There is no doubt that reputable companies are producing oils of quality and marketing then in such a way that their brands are easily procurable. It is a case of taking their scientific word that their products are good, unless service disproves them.

But assuming that an engineer purchases one of these good oils, the question of its quality does not end there. That oil must reach the pistons and bearings in its true condition to produce good results. For used oil, polluted with foreign matter



THURSTON TYPE TESTING MACHINE FOR INDICATING OIL DURABILITY

or with fuel oil and carbon descended from the combustion chambers, is distinctly harmful to wearing surfaces.

This is one great lubrication problem that has featured itself in the development of all types of internal combustion motors. Its importance increases as the lower grades of fuel oil are used. It has had (until the present day) its least manifestation in the automobile motor, due of course to the available supply of good gasoline during the development period of the automobile.

It has been found that a kerosene motor cannot operate entirely successfully with crank case lubrication, due to a certain amount of descending fuel and carbon which no device invented to the present day can obviate. Good oil, even the highest quality, causes tremendous wear in kerosene motors after it has been polluted with fuel and carbon from the combustion chambers.

Reproduced herewith are a number of charts illustrating tests conducted with fresh oil and also oil of the same grade taken from the crank case of a kerosene burning motor after a number of hours' service. The purpose of making the tests was to determine the extent of deterioration of oil due to use and pollution.

Chart I represents a Thurston type testing machine for indicating oil durability. As a full description accompanies the illustration of this machine, its principle is readily understandable to anyone unacquainted with its design.

Chart II has to do with the comparative viscosity of fresh oil and this same grade of oil after use. You will note an astounding decrease in viscosity after the oil has remained in the crank case for ten hours of service, due of course to the condensation of fuel and its descent into the oil. A still further decrease in viscosity is noticeable after twenty hours' service. These results merely prove the fact that fuel mixes with oil to a marked extent. For the proof of detrimental effects we may turn to Chart III, which indicates the results of a durability test on the Thurston testing machine.

Given a set of constant conditions, fresh oil proves itself 100% more durable than polluted crank case oil. This chart is only one of a number covering the field of various types of kerosene and gasoline motors up to sixty horsepower. In all cases the results are similar to those illustrated, sometimes more or less serious, depending upon the age and design of the motor and the skill of the operator.

There is one thing that these charts cannot show, and that is the amount of sediment and gummy substance discovered in the used oil. It is reasonable to suppose that this foreign matter is derived from two sources, the fuel and the air. In considering marine engines, which operate where air is clean, it is apparent that fuel is the only source.

These samples of used oil, referred to in the charts, were loaded with black deposits. Particles of this material cling to the inside parts of the motor. It is not likely that the lubricating oil was at fault, for one of the best grades was used. And to anyone who has had experience in the distilling of low grade fuels, it is apparent that the fuel must be blamed for any such conditions. And there can be no doubt that a mixture of this sediment and oil is no fit lubricant for the fine surfaces of a motor.

What, then, must be the condition in the Diesel or other type of fuel oil burning engines installed in motorships? The factor of pollution operates in these cases to its most dangerous degree.

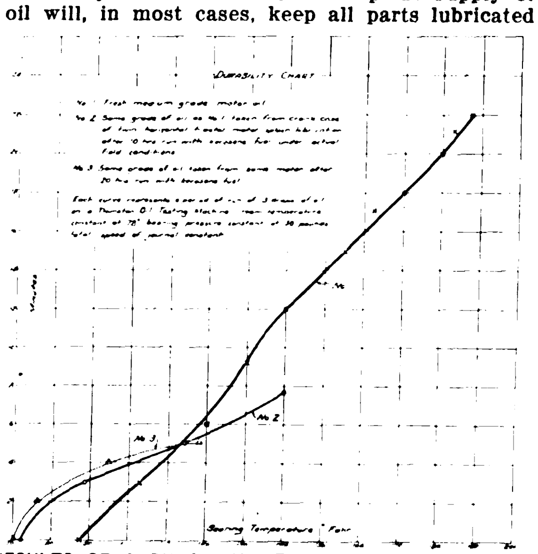
The Diesel or hot surface types of motors with enclosed crank case offer every opportunity for the accumulation of putty-like material. Many engineers have been unfortunate enough to have been informed, through experience, concerning the accumulation of a mass coating the inside walls. They know that undue wear accompanies such conditions and that a more efficient mechanical means of lubrication must be incorporated in the engine.

And so, in considering ways and means of incorporating good lubrication in motor design, there is one fundamental to which we must adhere—good oil without fuel pollution must be delivered in proper quantities to cylinders and bearings. With this in mind let us consider characteristics of oiling systems.

A familiar type operates, in general, as follows: A continuous pressure is maintained by a central oil pump which forces lubricant through the crank shaft to main bearings, crank pins and cylinders. This is used in trunk piston types of motors with enclosed crank cases. Since this lubrication is copious, a surplus accumulates in the sump of the crank case and is drawn out to be pumped over again through the crank shaft.

Note that this oil is used over and over again, passing through bearings, over the cylinder walls, and down into the crank case.

There is, in this case, no means of eliminating the descent of carbon into the crank case to mix with the lubricating oil, and such a condition is extremely serious. While the copious supply of oil will, in most cases, keep all parts lubricated



RESULTS OF A DURABILITY TEST ON THE THURSTON TESTING MACRINE

after a fashion, there is constant grinding wear which cannot help but mean an unsatisfactory installation.

There are as many variations of the above systems as there are designers, perhaps; but the main characteristic is the same—polluted, used oil is the lubricant. There are devices for the purpose of catching the descending carbon. For example, an article in Motorship, November, 1917, reads as follows:

"On this ship the great benefit of the cast iron oil tray fitted below the cylinders is to be seen. This collects the carbonized lubricating oil that drops down from the cylinders by the scraping action of the piston rings. In the case of a ship equipped with motors of different make, all of this sticky carbon falls into the crank housing and forms thick clusters on the walls. As this carbon falls in the form of very hard dust the advantage of collecting it is easily appreciated. Only, in the case of the "Emanuel Nobel" the trays are not

large enough. Oil mixes with it and it gets carried all over the engine room floors, rails, etc., making a very dirty engine room. However, it is better to have this carbon on the walls of the engine room, than in the bearings, even at the expense of a dirty engine room, although the latter can be avoided, as it is not a fundamental feature."

The author of this quotation has referred to a cross head type of engine, but unfortunately for our purposes, does not state whether bearing oil is carried in the crank case, or fresh oil is forced to the bearings in frequent small quantities. It is safe to assume, however, that the trays are for the purpose of keeping the carbon from mixing with oil carried in the crank case and finding its way to the bearings.

If such precautions must be taken in the cross head type of engine, the crank case system of lubrication with trunk pistons actually confines all this descending carbon right where it should not be. And men who have repaired this type of motor seem to be of one opinion in that the most noticeable thing when they open a crank case is the presence of a vast amount of a black gummy substance, clinging to the inside walls.

A few weeks ago I had an opportunity of visiting the engine room of the motorship "Brazil." These motors are of the cross head, 4-cycle Diesel type with enclosed crank case. The cylinders are constructed so that there is no opening into the crank case except, of course, one just large enough for the piston rod.

Fresh oil is forced to the cylinders by means of mechanical force feed lubricators, two feeds to each cylinder. A centrifugal pump forces oil into the crank shaft and into all bearings in the crank case in copious quantities. This crank case oil accumulates and is drawn through a filter and used again.

In this particular case this method has proved to be successful, and there has appeared to have been no undue wear on the bearings. Theoretically there is much in its favor, because no used oil is allowed to descend into the crank case from the cylinders, and therefore no carbon accumulates except that small amount which travels with the piston rods.

But it is obvious that in a motor with trunk pistons, there can be no separation of the lubricating system into two distinct sections, as has been done in the motors of the "Brazil." There is no means of eliminating the mixing of carbon with oil as long as the crank case system is used. As a result, wear on bearings and cylinders is inevitable, and this wear is bound to be so great that an installation of this kind is usually unsatisfactory.

The Sumner engine presents an example of a different system of lubrication, forcing oil to all cylinders and bearings by means of individual oil feeds. This engine, of the cross head type with open crank case, is illustrated in diagram, figure 4.

Mr. Sumner, designer of the motor, has employed two force feed lubricators, one with sixteen feeds forcing oil to four points on each cylinder; and another with twenty-two feeds for lubricating all main bearings, crank pins, cross head pins, and cross heads. A pair of these motors developing 400 h. p. each, consume not to exceed twenty gallons of lubricating oil in 24 hours.

A short study of the diagram figure 4 will display the method of lubricating all bearings and cylinders with individual oil feeds, and doing so with the greatest economy.

The cylinder lubricator is always filled with fresh oil, piped from the main oil storage tank, so that each piston is properly lubricated at four points by means of fresh oil only. If a slight surplus is furnished to the cylinders, it is burned and passes out through the exhaust. Each feed, however, is capable of being regulated to the exact number of drops per minute required.

The bearing lubricator receives its oil from a filter. The filter is supplied with oil from the sump of the crank case. This crank case oil is the surplus forced to the bearings which collects in the sump and is elevated by a small pump to the oil filter. Therefore all sediment and water is removed before it is used to replenish the bearing lubricator.

This method has proved to be ideal; (1) fresh oil only is used for the pistons; (2) due to the cross head design, no carbon reaches any bearings, and therefore good oil only is used for lubrication; (3) there is no waste. Steel guards confine the surplus oil from bearings so that none of it reaches the engine room floors.

The Sumner engine seems to have been designed with unusual consideration for the oiling system. The lubricator forces oil into a groove in the lower shell of each main bearing. A very unique device is employed for receiving oil from a lubricator feed forcing it into the crank pin and cross head pin. There are no ring and well devices and no centrifugal rings employed. The entire system has individual force feeds to each important bearing of the motor and these feeds have individual adjustments. The element of gravity does not enter, and the oil feeds stop and start automatically with the motors. An auxiliary hand crank permits the operator to force a surplus of oil to all bearings when starting or at any time during operation.

The Skandia Pacific Oil Engine Company also use the force feed lubricator with individual leads to bearings and cylinders. Surplus oil is collected in the crank case sump and can be filtered for re-use in the bearings if desired. In this way the carbon evil is eliminated by the use of fresh oil delivered constantly in small quantities to each cylinder and bearing surface.

The future of the motorship is concerned to no little extent with lubrication, and the problem presents very little that is new. For years past, the internal combustion engine has brought out this vital thing that we have discussed here in general,—all wearing parts must have good, unpolluted oil in proper quantities.

The few suggestions offered here have been general, but an effort has been made to emphasize this one important phase of the lubrication problem. Since heavy duty marine motors are bought for the advantages that they have over steam, the future of the motorship cannot be great unless the motors are built to last in service.

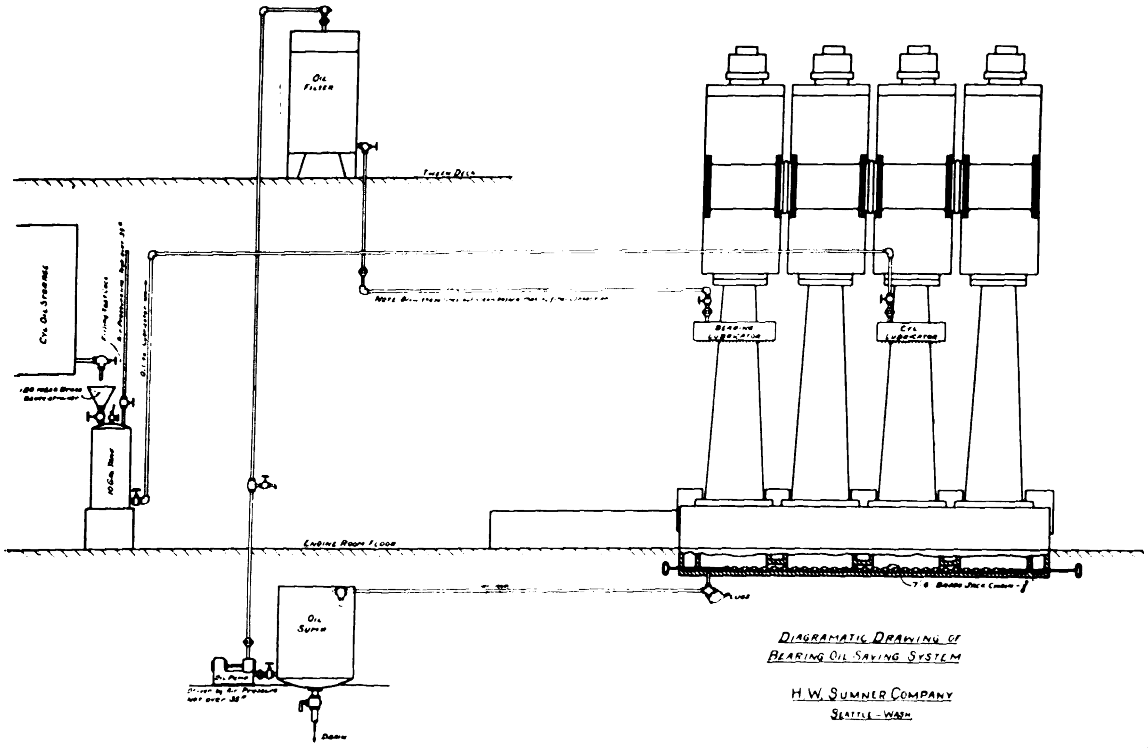


DIAGRAM SHOWING THE SYSTEM OF LUBRICATION IN THE SUMNER ENGINE BY MEANS OF FORCING OIL TO ALL CYLINDERS AND BEARINGS BY MEANS OF INDIVIDUAL OIL FEEDS

THE FOUR-CYCLE DIESEL FOR OCEAN-GOING SHIPS.

Although in some quarters there continues to be considerable diversity of opinion on the relative merits of two-cycle and four-cycle Diesels, there can be no question but that the latter type of engine easily commands the field, and is likely to hold premier position for a long time to come. One or two successful ocean-going vessels have certainly been built in which the propelling medium took the form of high powered two stroke installations, but, on the other hand, not a few fitted with machinery working on the same principle have given anything but satisfaction to their owners. First and foremost what is required in a marine set is absolute reliability, and if we go by performances of vessels in the past fitted with Diesel machinery, the four-cycle motor easily takes first place, especially where high powers are installed. It is admitted that the two-stroke engine has the advantage of occupying less space and is lighter in weight, which naturally means some increase in the deadweight carrying capacity, also the first cost is less, but the all important question is reliability, and the four-cycle Diesel we all know has long since proved itself to be a machine which can be depended upon for hard continuous service, even under the most adverse conditions. For proof of how the four-cycle is acquitting itself, one need only turn to that magnificent fleet of motor driven liners now sailing under the flag of the East Asiatic Company, of Copenhagen. The East Asiatic Company, who may well claim to be the pioneers of the ocean going motorship, have at the present time in service over a dozen vessels of the kind with machinery ranging from 1,600 h. p. to 3,400 h. p., besides a number of others building. It is eight or nine years ago since the Copenhagen firm built their first Diesel engined ship, the "Selandia," a twin-screw vessel fitted with four-cycle Burmeister and Wain machinery of 2,500 b. h. p., and the fact that they have since then continued to favor this particular motor says much for the efficiency of even the earlier four-cycle Diesel.

Although conditions in Great Britain at the present time are by no means favorable to the rapid construction of large motor vessels, a number of orders have of late been placed for twin-screw internal combustion engined ships. Messrs. Harland and Wolff, Ltd., have orders on hand for four 12-knot 13,000 ton deadweight carriers, some of which are for the Glen Line, and also three vessels of about 10,000 tons deadweight for Messrs. Elder Dempster and Co., Ltd., who, it will be remembered, have had two or three motor liners built on the Clyde, but disposed of them to other shipowners before completion. All seven vessels, it is interesting to note, will be given Burmeister and Wain six-cylinder four-cycle Diesels. The Elder Dempster boats will have machinery of 3,400 h. p., sufficient to give a service speed of about 10½ knots.—New York Journal of Commerce.

TAMPA BOARD OF TRADE PROTEST AGAINST REQUISITION OF MOTORSHIP "HOLDEN EVANS" BY U. S. SHIPPING BOARD.

At a special meeting of the governors of the Board of Trade of Tampa, Fla., on Nov. 18th, a protest was voiced against the taking over by the Government of the motor-driven oil-tanker "Holden Evans," owned by the National Petroleum Co. A telegram was sent to the United States Shipping Board, in which it is set forth that the plants of the American Cyanamid Co. at Brewster, and the Prairie Pebble Phosphate Co. at Mulberry, representing about one-third of the Florida industry, would have to be shut down if the "Holden Evans" is commandeered.

The prosphate companies named have contracted for the fuel to run their plants until Oct. 1, 1918, and cannot secure other contracts. As Diesel engines are used at these plants no other fuel can be supplemented. The "Holden Evans" is the only tanker owned by the National Petroleum Co., which located a terminal at Port Tampa a few months ago.

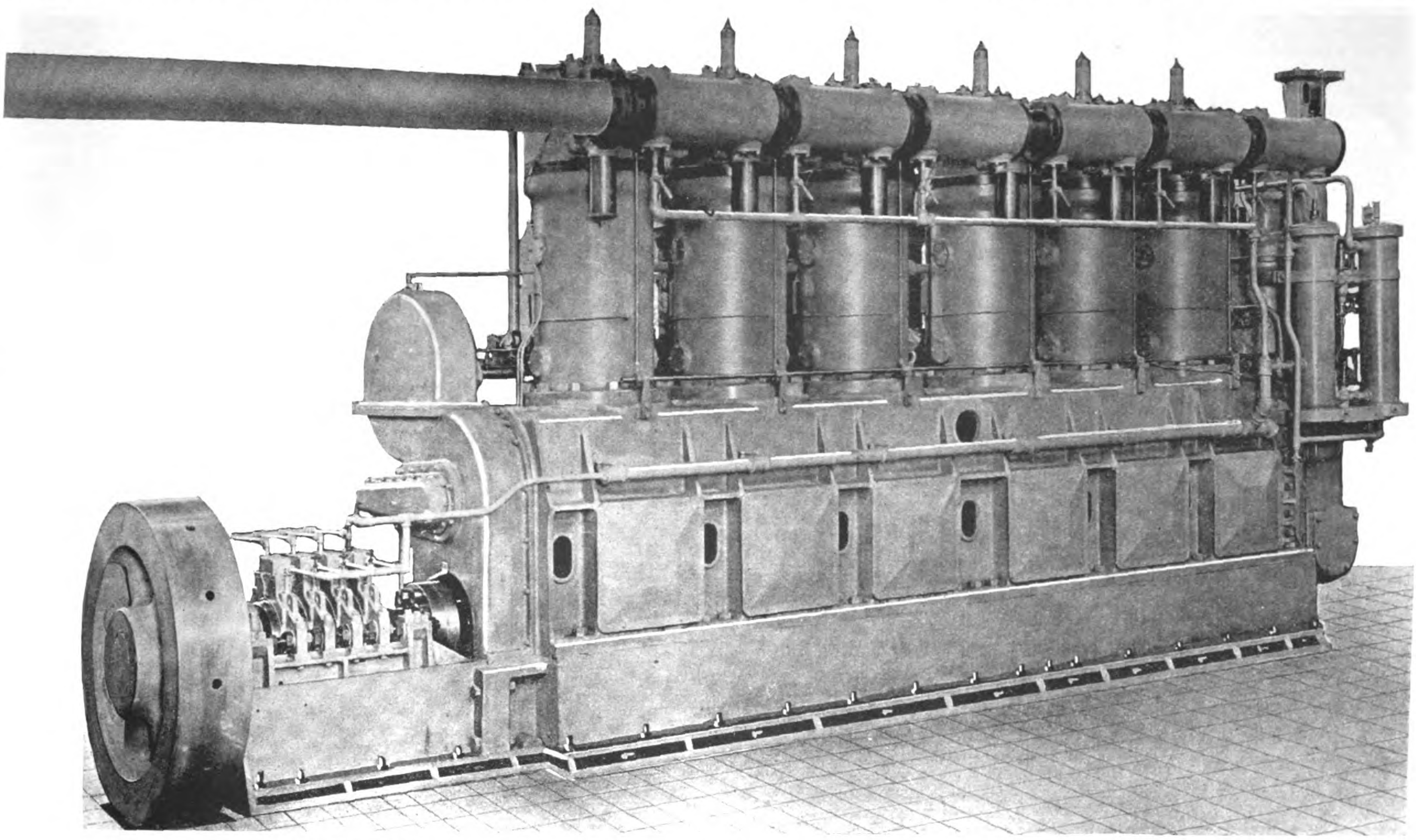
SAILING SHIP TAKES YEAR TO MAKE VOYAGE.

There recently returned to the United States the bark "Snowden" 1,033 tons, Capt. Alton S. Hatch of Islesborer, Me., which took one year less three days to voyage to the Gold Coast and back. The "Snowden's" next trip will be to South America. Her long trip shows the great importance of installing all sailing vessels with auxiliary oil-engine power without further hesitation.

The McIntosh & Seymour Marine Oil Engine

A New American Four-Cycle Diesel Motor Produced by an Old Firm of Steam-Engine Builders

WHEN a domestic engineering firm of repute, who have built up their reputation by thirty-two years of marine and stationary steam-engine construction, abandon the same for a new and rival system of power, namely the Diesel engine, is it not time for many of us to pause and reflect awhile, in order that we may regard the high-powered Diesel engine with the considera-



SIDE VIEW OF THE McINTOSH & SEYMOUR 500 B. H. P. SIX-CYLINDER, FOUR-CYCLE DIESEL MOTOR

tion and seriousness that it deserves? No responsible company with an established business, such as the construction of steam-engines, would make such a radical and expensive change unless they were absolutely convinced that the dawn of the crude-oil combustion-engine has arrived. That they made no mistake, either financially or from an engineering aspect, is perhaps demonstrated by their having received orders for 22 Diesel engines for American ships aggregating 10,000 b. h. p. before their first marine set had completed its tests. This apparently reveals a pleasing spirit of co-operation from the shipowners concerned, which tendency we hope will become general throughout the shipping circles of the United States, as soon as the Government once again gives shipowners a free hand in the construction and operation of merchant ships.

We are referring to the McIntosh & Seymour Corporation, of Auburn, N. Y., who about four years ago entered into the construction of stationary-type Diesel oil-engines, during which period they completed about 87 motors of 300, 400, 500, 700 and 1,000 b. h. p. for driving power plants on land. The commencement of the recent demand for motorships, however, caused them to decide to enter the marine field, although they are in a measure handicapped by their plant being so far from the seaboard and shipbuilding centers.

When they first took up the Diesel engine they decided that it was better to acquire by purchase the benefits of the experience of some European company, rather than going to the greater expense and delay of starting at the basement and working up to the roof without an elevator to assist them, so they secured a license from a Swedish company who already had built over a thousand stationary Diesel engines and who had engined many motorships. Those licensors were the A/B Atlas Diesels Motorer, then the A. B. Diesels Motorer, of Stockholm, who were building marine and stationary Diesel engines under the Hesselman system. The relations between the licensors and licensees now are closer than ever, and, as the parent company has a fully-paid capital exceeding six and a half millions dollars, it enables one to realize how important the industry is becoming.

As yet the McIntosh & Seymour Corporation have only produced two marine models that they have standardized, and the output of these single sizes has filled up their capacity for many months to come; but, during 1918, they expect to undertake the construction of engines of 1,350 b. h. p. per shaft (equivalent to about 1,550 steam i. h. p.) in six cylinders each. Other models, which are being constructed are 750 b. h. p. and 900 b. h. p.

The construction of the twenty-two 500 b. h. p. engines now building is a splendid manufacturing job, and effectually demonstrates the advantages to be gained, compared with reciprocating steam machinery, with its different-sized cylinders, pistons, and piston-rods, valves, etc. Here we have 132 cylinders, all exact duplicates, to mould, cast and machine; 132 pistons; about 800 piston rings; 264 inlet and exhaust valves; 132 injection-valves; 22 crankshafts; 132 cam-shafts; 132 connecting rods; 132 cylinder covers, etc., making standardization and rapid production a far easier matter. This in itself shows that quick construction of the American new merchant fleet would have been facilitated had our Shipping Board Emergency Fleet Corporation given the marine Diesel engine its rightful place in the country's building program. We understand, without confirmation, that delay in the delivery of some of the steam machinery ordered is causing officials not a little concern.

The McIntosh & Seymour 500 b. h. p. model, which is being fitted in eleven ships, of which four will be steel vessels, is of the single-acting, direct-reversible, four-cycle type, with trunk pistons and without crossheads and guides. There are six cylinders, 16 inches in diameter, with a stroke of 24 inches, and the rated-horse-power is developed at 185 r. p. m. at a mean-indicated-pressure of 96 lbs. per square inch. There is, however, a good reserve power, as the speed for continuous operation is 185 r. p. m. When developing 500 b. h. p. at normal operating revolutions, the engine shows a mechanical efficiency of 78 per cent and a mean effective pressure of 74 lbs. per square inch, which may be considered very good indeed, particularly as some of the European four-cycle Diesel engine builders of late have reduced their normal mean-indicated, and mean-effective pressures, so that only 72 to 75 per cent mechanical efficiency is shown. Lengthy shop-trials were made with the first engines, previous to installing the same in wooden vessels on the Pacific Coast and the fuel-consumption was shown to be a little over 0.4 lb. per b. h. p. hour at normal load. It also was shown that a speed reduction of 60 per cent was possible, which speaks well for the flexibility of the controlling and hand-governing apparatus.

A cylinder compression of approximately 480 lbs. per square inch has been adopted, while the air-pressure for fuel-injection is about 850 lbs. per square inch. The length of the engine overall including thrust-block and flywheel is 29½ feet, and the height is 10 ft. 10 inches from the center of the crankshaft to the top of the valves; but, 16 ft. clear above the crankshaft center is needed to lift out a piston for cleaning or inspection purposes. The overall-width of the engine is 7 ft. 4 inches and the weight is a little over 58 tons (long). It may be mentioned here that the flywheel is arranged aft of the thrust-block, which is the reverse to the general practice, and we see no reason why it should not pan out very well so the after end of the thrust-block forms a long bearing more than capable of absorbing its weight.

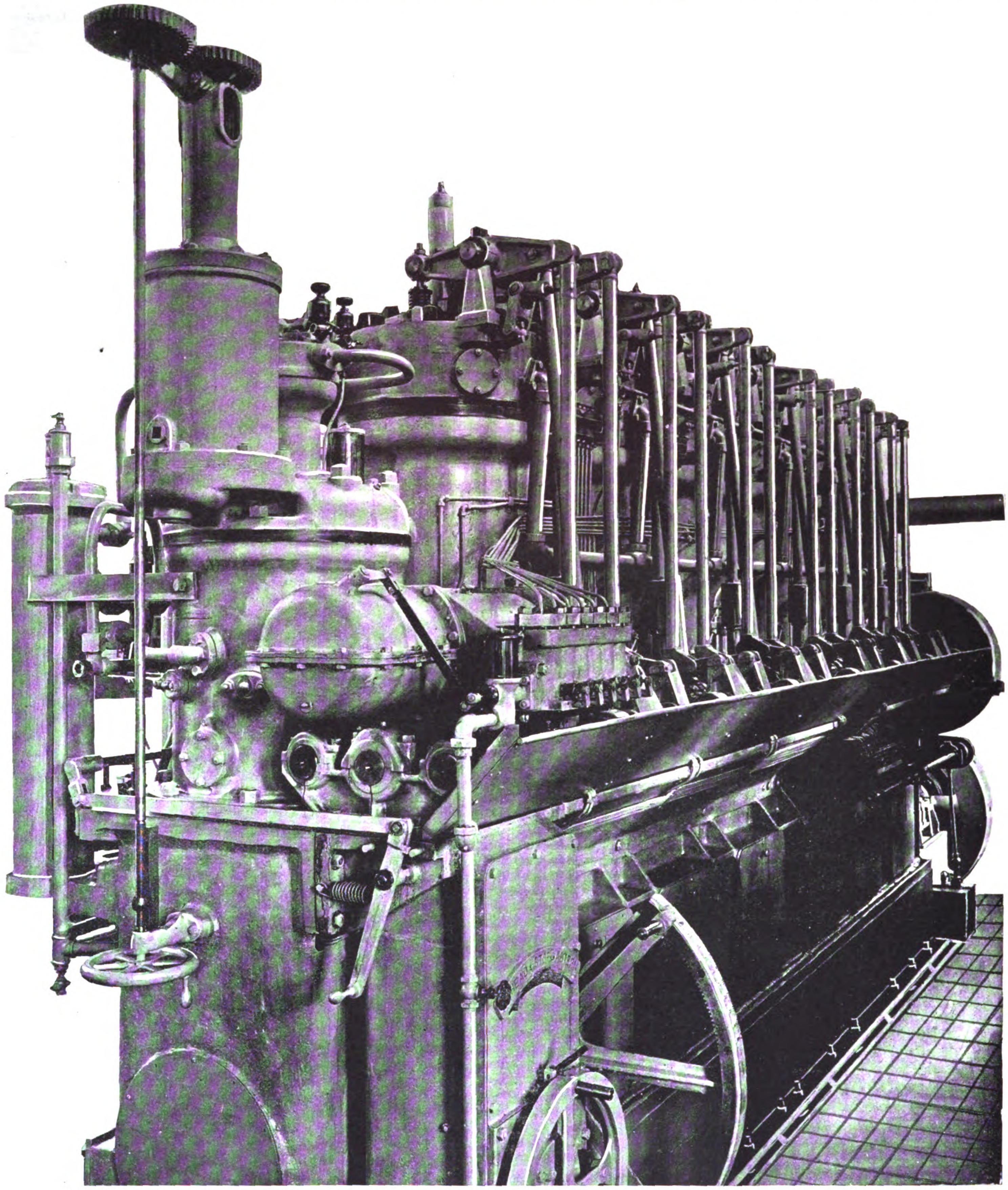
One most interesting feature in connection with the construction is that the cylinder castings are of semi-steel, whereas most Diesel engine builders have preferred to use close-grained cast iron, so the results no doubt will be watched with keenness.

The shop tests have brought forth very favorable comment from all those who have witnessed the same. On the long period runs marine grades

of fuel-oils and crude-oils from Oklahoma, Texas, Mexico, and California were used.

The marine model differs in many respects from their stationary engine, and the cast-iron framing that carries the cylinders is of the box, or enclosed, type, and is mounted on a heavy cast-iron bed-plate. Light metal doors are provided on both sides of the box-frame permitting access engine. This camshaft is driven by a chain of gears off the crankshaft at the after end of the engine.

Running parallel with, and on either side of, the camshaft are two layshafts and these carry link-pieces, which are connected with the toes of the feet of the valve push-rods that can be seen in one of the illustrations. The heels carry the locked. This prevents any damage through faulty or careless maneuvering. We have omitted to mention that the outer lay-shaft carries the link-pieces for the inlet and exhaust valve actuating mechanism, while the inner layshaft carries the link-pieces for the fuel-injection and air-starting actuating mechanism. The average time taken from full ahead to full astern over 50 ma-



INBOARD SIDE OF THE McINTOSH & SEYMOUR MOTOR

to the crank-chamber and bearings. The cylinders have separate heads and one fitted with removable liners, so that the cylinder casting itself is of very simple form, especially as all the four valves are carried in the head. These, of course, are the fuel, air-starting, exhaust, and air-inlet valves. There also is the little automatically operated compression-relief valve, which blows off when any abnormal pressure accidentally occurs.

On the cylinder covers are brackets carrying the valve-operating rockers, the rockers being actuated by long push-rods, made of steel tubes, and carried from the camshaft, which is arranged on the crank chamber housing on the front of the rollers for running on the cams that lift the push-rods, and in turn rock the levers and depress the valves. In order to bring the astern cams under the rollers the camshaft is moved in a fore and aft direction, and this is accomplished by turning the hand-wheel. The latter connects with a ratchet device that carries a curved diagonal slot in which is carried the lower end of a fulcrumed. lever, the upper end of which is fixed to the camshaft, so that as the ratchet-device is raised or lowered by the turning moment of the hand-wheel the camshaft is moved fore or aft as the case may be. Other controls, such as that operating the link-pieces which decide the position of the feet of the pushrods, are inter-neuvers, is eight seconds, and this even may be reduced.

There is a separate fuel-pump for each cylinder, and this pumping act is arranged on the front of the engine at the forward end just over the camshaft, where it is very accessible. Governing is arranged by varying the length of the strokes of the pumps, and the method employed is very neat indeed, and so far as we are aware only two other oil engines—one Austrian and one British—ever have employed it, although we believe that McIntosh & Seymour have used it for some years with their steam engines.

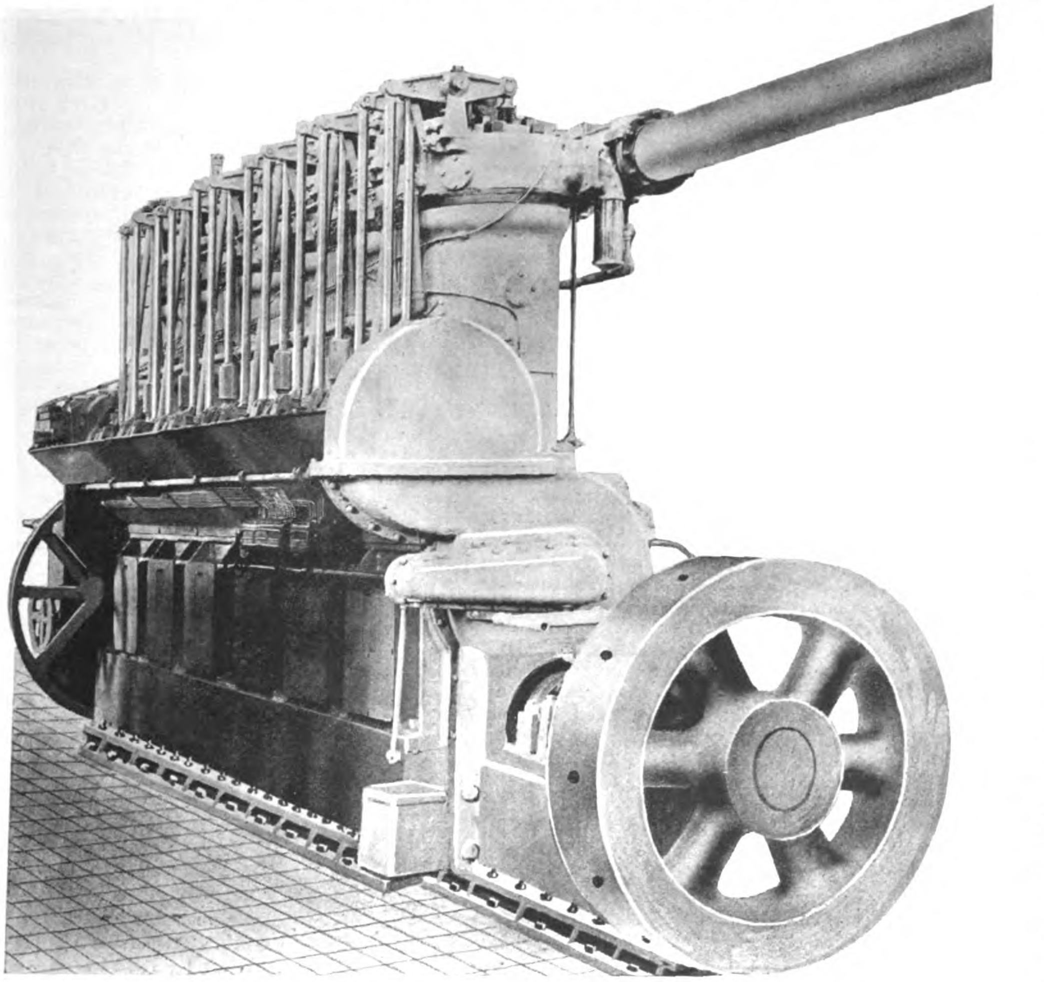
There is a double eccentric, that is to say one

eccentric inside the other, one eccentric providing the motion for working the plunger and the other for varying its travel. Nothing could be more simple, and its action in practice is as nice as in theory.

The three-stage air-compressor, with its inter and after coolers, are situated at the forward

pressure being 80 lbs. Every start the average pressure reduction is about five pounds.

Force-feed lubrication has been adopted, and the cylinders, piston-pins, and compressor are lubricated by the Richardson-Phenix Force Feed oiler. This is driven by timing gears, so that the oil is delivered to the working parts during the



END VIEW OF THE 500 H. P. McINTOSH & SEYMOUR ENGINE

end of the engine and is direct driven from the crankshaft. The valves are all accessible and removable as a unit, making the same a simple operation. The makers have been generous with their equipment, and the starting-air tanks carry sufficient air at 332 lbs. per sq. inch to start the engine forty-four times, the minimum starting

portion of the cycle that is most beneficial. For the crankpins, mainbearings, and other journals a gravity system supplies the lubricating oil by means of gang oilers. The oil is collected at the base of the crank-pit, and is returned, via a filter, to the bearings. A small pump driven off the camshaft handles this oil.

Existing Ferro-Concrete Motorships

SOMETIMES, but by no means always, other countries get up and do things while we are talking about them or wondering whether such things are possible or practical. Unfortunately, the steel motorship industry is one of these developments with which we have been a little tardy, and now we are falling behind with ferro-concrete constructed motorships. Norway already has several actually in service, Great Britain has one barge in operation and some motor lighters under construction. The British barge is a seventy-footer and at the time of her launching the concrete of the upper part of her hull was only eight days old. On trial her sea-going qualities were thoroughly tested, and she behaved excellently. What is more important under the circumstances, vibration was found to be non-existent, which speaks well for the method and material of construction, and for the type of power installed.

The name of this interesting motor vessel is the "Nansenfjords." She is 84 ft. long by 20 ft. breadth with 11 ft. 6 in. draught, on which she carries 200 tons of cargo. Her propelling power consists of one two-cylinder 80 b. h. p. Bolinder surface-ignition type crude-oil internal-combustion-motor, which gave her a loaded speed of 7½ knots. On deck is an oil-engined winch for handling the cargo through the maximum-sized hatch provided. The crew's quarters are forward and the captain's, mate's and engineer's cabins are on deck at aft.

Reinforced concrete construction will appeal to many tug owners because the use of the marine oil-engine renders the same feasible, inasmuch a concrete motor-driven tug will have a similar displacement to a steel-built steam tug. Previously some tow-boat owners found that a motor-driven tug was a little too light in displacement for complete towing efficiency, due to the weight saving in the machinery. The greater weight of the concrete hull, however, nicely balances matters, and makes the oil-engine very valuable for the purpose. On the other hand the steam-driven concrete tug is likely to be so heavy that much efficiency will be lost. Therefore, if only a good motor-driven concrete tug is demonstrated to shipowners we can be certain that the proposition will be very seriously considered by them, especially as steel tugs are so difficult to obtain today.

BUNKER COAL $60 PER TON AT BUENOS AYRES.

It is reported that bunker coal now is selling at $60 per ton in Buenos Ayres. This is equivalent to a Diesel motorship using oil-fuel costing $300 per ton, without taking into consideration the 10 per cent to 12 per cent extra cargo carrying-capacity of the motorship, also the absence of stokers and stand-by charges.

THE MOTORSHIP "OROTINA."

The new 100 tons (net) motorship "Orotina" has been chartered by the Panama Railroad Co. for service between Christobal and Port Limon, Costa Rica, and will carry fruits, vegetables, sugar, etc. The use of this motorship has enabled the Panama Railroad Co. to discontinue the use of the schooner "Parolie," which they have been using on the same route.

RE "HEAVY OIL-ENGINE FACTS AND FALLACIES"

Editor "Motorship":

I would appreciate it very much if you see fit to give publication to the following discussion of Mr. Crowly's article entitled "Heavy Oil Engine Facts and Fallacies."

Mr. Crowly's article appearing in the December issue of "Motorship" is very interesting. It must be admitted that the tendency existing today among shipbuilders is to stint the installations of auxiliary oil engines in motorships.

It must be conceded that a great deal of Mr. Crowly's remarks are well founded but the writer takes issue with this gentleman on one or two points which he cannot allow to go unchallenged lest the motor interested public accepted them as a fact.

In the first place Mr. Crowly says that the hot bulb engine cannot burn heavier oils than 30 degrees Baume. That 24 degrees Baume and even heavier oils can be used is proven by the installation and operation of not less than twenty-four Skandia 240 h. p. 4-cylinder engines now installed in auxiliary wooden ships on the Pacific Coast.

These engines have all been built in the Oakland shops of the Skandia Pacific Oil Engine Company and there has never been any complaint on the part of the owners or operators from the inability of these engines to successfully burn oil of this gravity.

Again the statement is made that "the mixture in this type of engine to avoid pre-ignition cannot be made until just prior to top dead center, and whether it can be made either wholly or partly prior thereto, depends upon the bulb."

We will concede that injection timing does depend wholly or partly upon the design of the bulb, but we must state that injection should be timed to take place a considerable distance before the piston arrives at "top dead center."

The timing is a matter of considerable experiment and experience. This is no doubt one of the important contributing factors towards the success of the European hot ball engine of which the Skandia is a direct counterpart.

The writer only recently had occasion to view the operation of an American made hot ball ignition engine of about 40 h. p. in a two-cylinder combination. The engine when under half load did not develop sufficient heat to keep both hot balls at proper temperature and it became necessary under half or reduced loads to operate one cylinder only.

It is quite evident that the manufacturer of this engine depends entirely on the heat of the hot balls for ignition, whereas, the Skandia engine uses a combination of the heat of the hot ball and heat of compression to attain this result.

As a result of this design, it is entirely possible to run the Skandia engine indefinitely without load (except the frictional resistance or moving parts of the engine) and keep the hot balls at a sufficient temperature to cause ignition.

It is unnecessary in using 24 degree Baume oil to have any water injection to control the temperature of the head as the head is water cooled and the only uncooled portion of these heads is the hot ball.

Yours very truly,
G. N. SOMERVILLE,
Engineer, Skandia Pacific Oil Engine Co.

ITALIAN-BUILT SUBMARINES FOR SPAIN.

Particulars of the three submarines—recently acquired by Spain from the firm of Fiat San Giorgio—are given in "Vida Maritima," which points out that this event is an honor for the Italian shipbuilding industry, which, in spite of the war, has coped with the great military and naval operations of the Italian Government and the Allied nations, but has also succeeded in filling orders for its foreign clients. The three submarines in discussion have a displacement when immersed of 200 tons, displacement when emersed of 318 tons, a maximum length of 45.63 metres, a maximum width outside framework of 4.22 metres, a maximum depth from keel of 3.00 metres, a height of deck beyond the line of flotation in normal conditions 1.09 metres, a reserve of maximum flotation of 45%, a reserve of maximum flotation with the superstructure open of 21%. These vessels belong to a type regarded as especially suitable for coastal defense and for such use have been employed in the Adriatic. The three submersibles present the qualities common to all the craft, no matter what the size, turned out by Fiat San Giorgio. The outstanding feature of the Laurenti type-patent, Fiat San Giorgio—consists in the absolute separation of the two hulls in the vital part, one completely interior and one completely exterior.

MOTORSHIP

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THE TRAINING OF MOTOR ENGINEERS.

No one will dispute that there is a dearth of good marine oil-engineers, but few shipowners will acknowledge that the responsibility of this situation is to a not inconsiderable measure due to themselves. A large number of motorships and motor auxiliary vessels have been ordered during the last eighteen months and in most cases the owners have calmly awaited the completion of such craft, before endeavoring to engage motor engineers, instead of engaging good steam engineers, or good motor mechanics, several months in advance of the trials of the ship and sending these men to the works of the builders of the oil engines, thus enabling them to become properly familiar with the design and operation before the vessel is placed in service.

What is the position today? Nearly every shipowner foresees and admits that the motorship is the mercantile vessel of the near future. Yet, very few individual attempts—certainly no collective efforts—are being made to prepare to meet the engineer situation by training young lads to operate Diesel motors and surface-ignition oil-engines. Our recent suggestions for a training ship unfortunately have not met with the slightest response from shipowners.

The states of New York and Massachusetts have two school ships, namely the "Newport" and the "Ranger," aboard which boys are trained both in navigation and marine engineering; each vessel carries about 100 cadets, and 40 to 50 lads graduate each year per ship, yet about 50 promising young lads have to be turned away every year.

The "Ranger" is a steel craft of 1,261 tons, and the "Newport" is a composite ship of 1,010 tons, both being steam-driven and equipped with auxiliary sails.

Here is an excellent opportunity for some American shipowners to prove that their patriotism does not button-up with their pockets, by forming a syndicate to furnish these two splendid ships with complete oil-engine installations in order that their cadets may become thoroughly familiar with the new type of machinery.

In one vessel could be fitted a two-cycle type true Diesel engine, and the other a four-cycle type Diesel engine, while the engine-room auxiliary machinery could be electric, the current for which to be furnished by surface-ignition oil engine-driven dynamos, and the ships' launches could have gasoline-kerosene electric-ignition motors. Thus every phase of the marine internal-combustion engine would be laid before these cadets.

As an alternative our previous suggestion of a new twin-screw auxiliary ship equipped with all these types of power could be built. But, some wealthy shipowner must need make the first start. We shall appreciate that gentlemen signifying his willingness to us in writing! Then we will take up the matter with the owners of the vessels in question.

THE USE OF THE METRIC SYSTEM.

During the last few years a number of domestic engineering companies have undertaken the construction of foreign-designed marine oil engnes under license, and in most cases have re-drawn the manufacturer's drawings and converted the dimensions from the metric system to inches and feet measurement. A few have retained the original drawings and have used the metric system without trouble. Writing on the relation of the metric system to war orders the financial editor of the New York "Times" says:

"Every now and then the financial distrct hears of more big ammunition and gun contracts placed by the War Department, which cannot be officially verified because of the stringent secrecy provisions attached to the contracts, but which are generally considered accurately reported. The chief feature connected with them, of course, is their magnitude; but another interesting feature whose implications have not been so closely studied is the fact that all these contracts are in the metric system. The War Department has apparently definitely committed itself to the step of shifting over to the metric system in the middle of its huge expansion program. Not least of the hidden romances of the war will be the story of how all the tools, dies, gauges, etc., needed for this change were found."

AMERICAN SAILING SHIPS AND UNDERWRITERS.

The following remarks culled from the British shipping paper "Fairplay" are of not a little interest, although we do not necessarily agree with any of the statements:

"A large number of American sailing-ships are being diverted into ocean trades, and underwriters would do well to look closely into their condition before accepting risks upon them which are bound to result in heavy claims. Most, if not all, of the vessels have been employed in short trades on the American seaboard, and are quite unfitted for long voyages, while, moreover, the masters and officers are not accustomed to the change in the trade. Numerous cases have already been reported of vessels which have had to abandon their deep sea voyages owing to their condition, and more will probably be heard of this later on. It would be well, also, if underwriters were to exercise care in the acceptance of risks on new wooden ships, because in most cases this is an entirely new industry, and it is impossible to secure labor capable of handling work in a craftsmanlike manner."

In any event we believe that these sailing-ships will meet with greater favor from the underwriters if they are adequately equipped with auxiliary motor power.

MOTORSHIP VERSUS SAILING SHIP.

Is it any wonder that we continually urge upon the Shipping Board the importance of installing oil-engined auxiliary power into all existing sailing vessels when we get such reports as the following? Recently a Norwegian Diesel-driven motorship arrived at San Francisco consigned to Balfour, Guthrie & Co. While enroute from oriental ports she passed a five-masted schooner in latitude 1 degree and longitude 175 degrees west. This sailing vessel was **seventy days out** from an Eastern port and also was bound for a Pacific coast port laden with a much-needed cargo. Yet motor-driven auxiliary schooners built recently on the Pacific coast are making voyages to Australia, taking only thirteen days longer than the fast mail-carrying steam liners.

Needless to say the motorship mentioned above made good time from Ceylon and other ports of call and brought 5,000 tons of raw sugar from Manila, 2,250 tons of copra, 5,500 barrels of flax, and 20 tons of lumber. Yet her fuel consumption was only about seventy (70) barrels of crude-oil per 24 hours, although her speed is about 11 knots, and sometimes a little over. The steamship capable of such a performance has yet to be built —geared turbines or otherwise.

483 MOTORSHIPS IN LLOYD S REGISTRY.

A comprehensive idea of the importance of the marine oil-engine and motorship building industries may be obtained by glancing through the motorship section of the latest Lloyd's Registry of Ships. Together with some ships in the supplements, there are no fewer than 483 motor vessels classed with Lloyds, most of which are crude-oil engined.

In this number are not included the hundreds of big Diesel-driven tankers, tug-boats, passenger, and cargo-ships on the Russian inland seas and lakes, nor does this number include many motorships classed by the Bureau Veritas, or the British corporations, or the hundreds of naval motor-craft in service. Then again, there are many motor vessels built since the war that have not been allowed to appear in the registry, also many motorships built in Germany. There also are thousands of fishing-boats, tugs, small freighters, and general utility craft, which are not classed with any registry and which are motor driven.

RATIO OF EARNING-CAPACITY TO DISPLACEMENT.

Our contemporary "Shipping" of New York, apparently unwittingly brings up a very strong point in favor of motorships in an editorial leader in the issue of December 1st, last.

In discussing the question of fabricated steel ships, the editor says:

"It behooves shipping people to keep an open mind anent the feasibility of preserving after the war the methods introduced at present into the shipbuilding industry for reasons which have nothing whatsoever to do with the necessities of trade in open competition. In cargo boat design, speed and other factors being equal, efficiency is to be reckoned by the ratio of carrying, or earning, capacity to displacement. Displacement is that for which the shipowner pays, while the return on his investment can only be obtained out of carrying capacity. Therefore, the ship that carries the most cargo—other factors being equal—on the smallest displacement is the cheapest ship to its owner and nothing that can be said in favor of standardization can offset this simple problem of commercial arithmetic. It is, indeed, in the matter of increasing the earning power per ton of displacement that the ingenuity of naval architects has in the past been put to the severest test, and to assume that ships can be so standardized as to be all turned out of the same pattern, is to deny that naval construction is a progressive science, a proposition which is contradicted by the most cursory study of the evoluton of ship design in the last half century."

Hardly any better argument for the motorship could be raised, for it is becoming a well-known fact that if we take a steamer and a motorship of the same given loaded displacements the motorship will have from 10 per cent to 12 per cent more cargo in her hold and a greater cruising radius. This larger earning capacity means much to the shipowners' profits at all times, because ten motorships will do the work of eleven steamers of similar size, and, at a greatly reduced operating cost, because of the remarkable economy of the oil-engine.

JOURNAL OF COMMERCE (N. Y.) SOUNDS A WARNING NOTE.

Marine oil engine men in the United States emphasize the fact that while a large number of motor vessels, well over 100, are now building in American shipyards, no contracts at all for further ships are being let. It is recognized that the policies of the Shipping Board must necessarily be somewhat conservative as far as keeping to proven types of ships is concerned. On the other hand, it is asked what is to become of the American marine oil-engine manufacturers after the war, if European countries are to continue their already considerable start.

It is declared that if no further contracts are forthcoming for motorships the United States, after the war, will have to rely very largely upon foreign engines for motorships built in this country. Even as it is, it is stated that the imports of marine oil-engines into the United States since the war began has been very great. One firm, making an improved Diesel engine, is said to have imported $2,000,000 worth of engines into this country during the past two years.—From the Journal of Commerce of New York.

THE BLACK CRIME LIST.

One of the twelve cases of black crime by Germany on the high seas recently selected by the British Admiralty for placing before the International Conference of Merchant Seamen, was that of the little steel motor tankship "Hestia" a vessel of about 600 tons, owned by the Royal Dutch Shell Petroleum Company. This vessel was sunk on March 30th last, evidently smoke from her oil-fired auxiliary boiler betraying her presence to the U-boat. The black crime in connection with the sinking of this vessel was the firing on her boats killing six Dutchmen and seven Chinamen of her crew. The "Hestia" was fitted with a six-cylinder reversible Werkspoor-Diesel motor of 500 b. h. p. at 175 r. p. m.

NEW YORKERS BUY THE TUG "BRITTANIA"

New York interests have purchased the tug "Brittania" from the Coombs Company of Appalachicola, Ga. The sale was effected through the Pensacola Maritime Corporation who acted as agents for the owners. No consideration was announced.

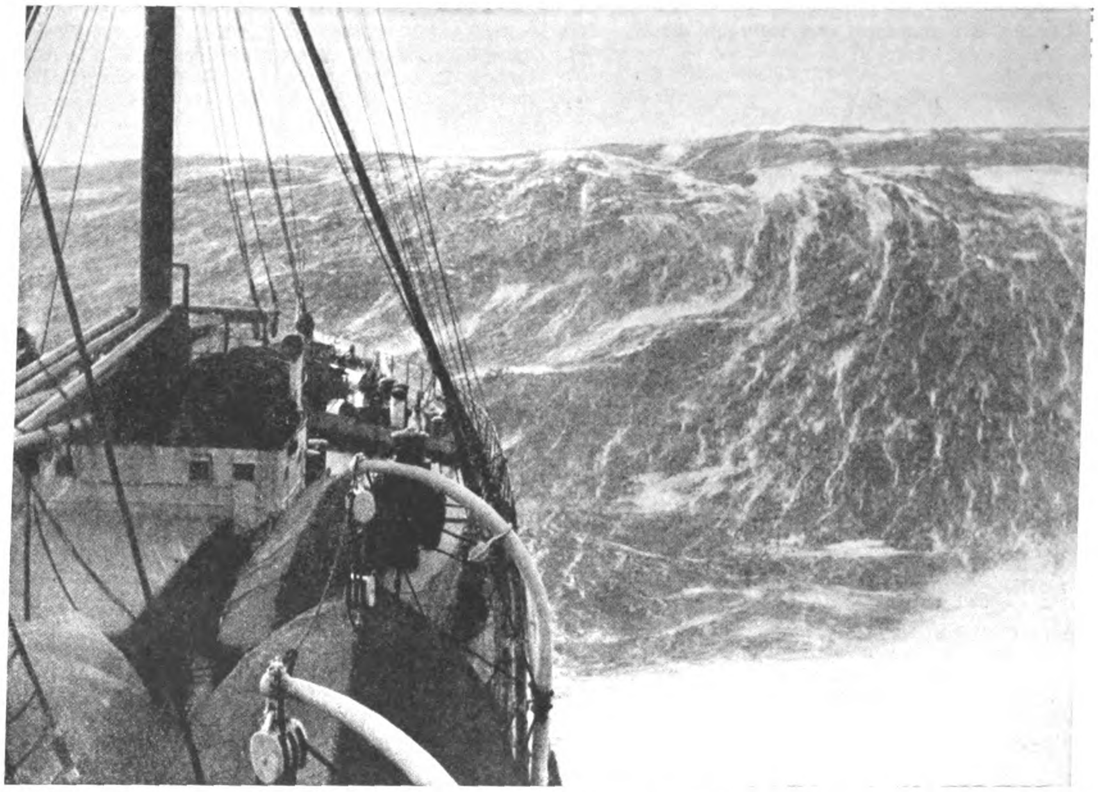
Submarine Activity, Evasion and Patrol Work in the Zone

Some Practical Notes on the Situation

ONLY those who have travelled some of the oceans and big seas of the world are properly conversant with average maritime conditions; others can have no real conception of the present submarine warfare; thus, anyone who has not crossed the ocean cannot be capable of finding a satisfactory solution of the great underseas peril that still confronts the allied nations, and that is why hundreds of suggestions, although seemingly feasible, have proved useless in this connection.

We are reproducing on this page an illustration (Fig. 1) from our contemporary "Sea Power," showing in a striking manner the marine conditions frequently met with in the Atlantic ocean, and in the North sea, and which will assist to render comprehensive some remarks concerning submarine activity; submarine patrol work; the eluding of submersibles by freighters; and, the destruction of submarines by war craft. The crest of the wave shown in the illustration is, so far as we can judge, about a quarter-mile from the crest of the next wave, and about 35 feet high from trough to crest. We personally have seen larger waves running day-after-day for over a week.

The big German U-boats constantly are called to operate in such sea conditions, and partly because of this fact it is our belief that the best type of freight or tank ship to elude the submarine is the smokeless and funnelless Diesel-driven motorship. In the illustration in question the photographer was stationed on the bridge of the ship, which is about 40 ft. to 50 ft. above the normal surface of the water. Yet, although the air was clear at the time, it is obvious that it was only possible to see a comparatively short distance ahead, except when the ship was passing over the top of the wave. But, the navigator of the submarine is stationed only about one-fourth as high as this!



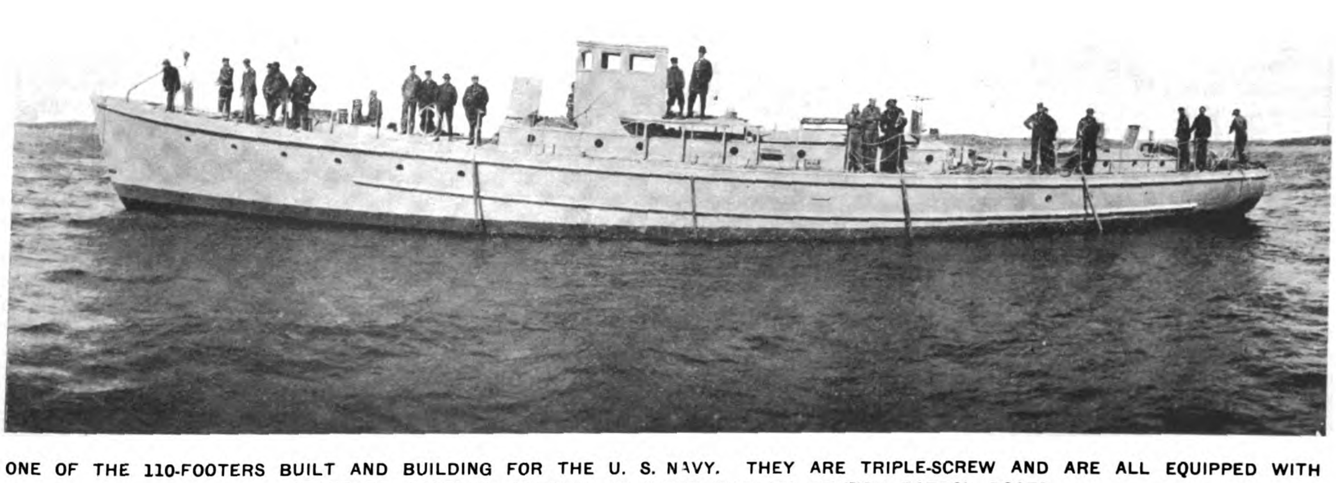
THE GERMAN U-BOATS FREQUENTLY HAVE TO OPERATE IN A SEA-WAY OF THIS NATURE. IT IS EASY TO SEE HOW DIFFICULT IT WOULD BE FOR THEM TO DETECT CAMOUFLAGED, MASTLESS AND FUNNELLESS MOTORSHIPS. THIS PICTURE WAS TAKEN FROM 50 FEET ABOVE THE SURFACE OF THE WATER; BUT THE NAVIGATOR OF THE SUBMARINE IS ONLY ABOUT 12 FEET ABOVE THE WATER

No better and more vivid illustration of this has been given than the Royal Italian official War Kinematograph pictures depicting the Italian fleet patrolling the Adriatic sea. Some of the pictures were taken from the fighting-tops of a battleship and really were wonderful. At times some of the other craft were completely hidden behind the waves. The whole series of pictures thoroughly show the difficulties of submarine patrol.

It consequently becomes easier to understand how difficult it is for the crew of a submarine (whose highest observation posts are not more than about 12 ft. above the water when operating on the surface; or about 4 ft. when running submerged with only the periscopes showing) to see a ship several miles away, unless the said vessel betrays her presence to the submarine by means of a trailing cloud of smoke several hundred feet above the sea. Under such circumstances a camouflaged motorship would pass undetected within two to three miles of the submarine, and even closer, ninety-nine times out of a hundred. Even with a much smoother sea the camouflaged motorvessel would be exceedingly hard to detect, especially if she had no masts, as well as no smokestack, and at nighttime as there never would be any sparks from glaring coal to reveal her position to the lurking U-boat, obviously the lookout on the submersible would need very keen perception to see a motorship.

This illustration also supports our previous contention, which we made nearly a year ago, that motorcraft under 100 ft. are of little or no use for chasing submarines except near the shore, and that much bigger craft are needed. In such weather as that shown, even a 110-footer would have all her work cut out to look after herself, and would be unable to fire a gun with any degree of accuracy, even if she could locate the submarine. In fact, if the submarine were a mile away a chaser of this size may not be able to catch more than momentary glimpses of her, even if at all, owing to the intervening waves obstructing the vision. If the submarine did see a 110-footer alone, she no doubt would fight her, and the lighter-armed, wooden-built, chaser probably would be blown sky high in about five minutes. Her only chance would be to drop a depth bomb if the U-boat submerged. It should not be forgotten that all the German submarines have 4.5-inch guns, and some larger, and have armored decks.

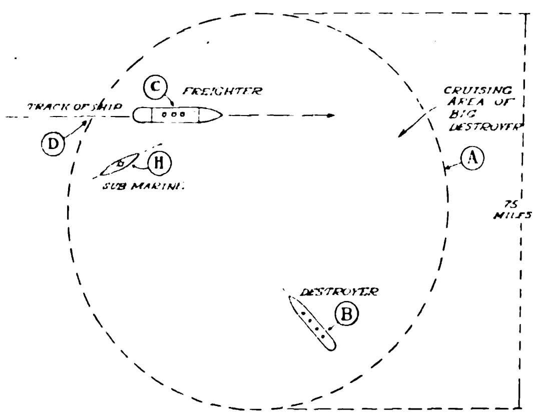
We must not regard the submarine as no longer being a most serious matter for this country and our allies to tackle; because, as pointed out in our December issue, in the six months from March 4th to August 22nd no fewer than 1,426 British, French and Italian ships were attacked by U-boats, apart from American, Norwegian, Dutch, Swedish, Spanish, etc., ships. Neither does this number include the very large sinkings of last February. Even during the heavy winter storms



ONE OF THE 110-FOOTERS BUILT AND BUILDING FOR THE U. S. NAVY. THEY ARE TRIPLE-SCREW AND ARE ALL EQUIPPED WITH STANDARD GASOLINE MOTORS, AS WERE THE 550 BRITISH PATROL BOATS

of November and December the total sinkings of neutral and allied ships averaged about 25 ships of over 1,500 net tons per week. Also, note that the allied tonnage figures refer to net register tonnage, not the cargo-capacity tonnage, which is what really counts, so the real tonnage of ships sunk is nearly double the British officially quoted net-tonnage figures. There has been quite a little misunderstanding in this connection, and it is best to make the matter clear.

About last February, when the sinkings reached the high water mark, a number of big submarines were seen,—craft of about 1,500 tons displacement of about 19-20 knots speed. Suddenly the sinkings dropped to a normal figure, and, the big submersibles no longer were seen, and all through the summer and fall the deadly work



BIRDSEYE VIEW DEPICTING A FREIGHTER ATTACKED BY A SUBMARINE IN A PATROLLED AREA, AND A DESTROYER SPEEDING TO THE SCENE

apparently was carried out by much smaller craft, indicating that Germany was using small craft of the type built in Belgium, also built in Germany and shipped in sections to Zeebrugge.

Then a rumor of what seems to be the real state of affairs leaked through Denmark, namely, that the big German U-boats had developed serious structural weaknesses and had to be withdrawn for reconstruction of both the machinery and hulls. Evidently this work has taken a long time, and probably over a year from last March will be needed to get all the large ones rebuilt and to complete new boats of a better design. So it most likely will be April or May next before Germany can get an efficient fleet of large U-boats operating in mid-Atlantic where they will be much harder to locate and destroy. Not only is the area so much greater; but the swarms of small patrol craft now used within a hundred miles of the British and French coasts will not be available for the purpose.

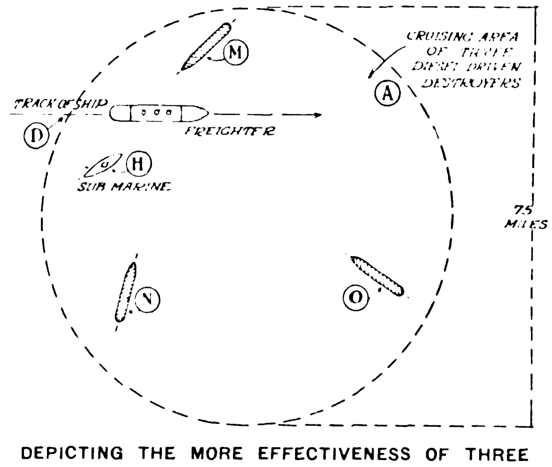
Meanwhile Germany has been using these smaller craft, which cannot wander so far away from their bases and so become much more susceptible to destruction. Thus it is no wonder that the allied demolition of submarines has greatly increased of late, which sinkings are considerably facilitated by the better patrol and convoy systems now maintained, not to overlook the splendid patrol work daily carried out by America's gallant torpedo-boat-destroyer fleet.

In seeking a solution to remedy and eliminate the terrible havoc made by the Hun U-boats is it not wise to first concentrate upon the factor that has enabled the submarine to be operated in the successful manner that it has been? That factor is the Diesel crude-oil internal-combustion engine. Without the Diesel engine—(or a development of a new power as equally efficient)—the awful submarine warfare of the past two years and over, being the case, it is Diesel power that must be being the case, it is Diesel power that mus tbe utilized to destroy and to evade the Diesel-driven submarine! For nearly three years the great fight against the Diesel-driven submarines has been waged. It has not yet been won! Will victory be attained until the Diesel engine be utilized to a much greater extent in the warfare against the submarines? This doubt will surely be realized by the powers that be in Washington, D. C.,—let us pray to God before it is too late!—and the Diesel engine is destined to play a far greater part in winning this long war than most of us yet imagine.

There will be many years of severe fighting on sea and land before victory is won. Win we surely will; but, our methods will be practically revolutionized before then. With the comparatively small and inefficient German submarines now in service the Allies are slowly—very slowly but surely—gaining the upper hand, but, the greatest peril for our troops in Europe and the greatest peril of our Allies, will come with the reconstruction, perfecting, and addition of Germany's fleet of big U-boats. Heaven help us all if we are not properly prepared to meet it! Preparedness is strength, so we must be in the position to meet the same whether it comes or not. This is imperative!

Let us hope and pray that Germany's engineers cannot successfully rebuild these large U-boats; but let us not put an atom of reliance upon such a possibility, for she has shown herself to be too remarkable a nation. (One with four guns was reported seen in December). Perhaps the first failure of these big submersibles was due to another great Diesel engineering blunder by Krupps. But, Germany has engineers who are much more advanced in Diesel design than Krupps, such as Blohm & Voss; the Maschinenfabrik Aügsberg; the A. E. G.; and the Weser Shipbuilding Co., etc.

To show how the public often are misled by stories, etc., in the daily press, we will mention that a week previous to penning these words we saw a photograph in a New York daily (Sunday pictorial section), illustrating what was purported to be a large number of German submarines captured by the French. In actual fact these submarines were boats of the French navy built by



DEPICTING THE MORE EFFECTIVENESS OF THREE DIESEL-DRIVEN DESTROYERS

Schneider et Cie from the Laubeuf designs which we recognized. Submarines rarely are captured; but more often are sunk.

There have been under construction, and on order, during the past year a large number of submarines for the U. S. Navy—seventy-two, according to Secretary Daniels' recent report. Had the steel used (or allotted for) their hulls, and their Diesel engines, been utilized for building Diesel-driven surface craft, America would have possessed a splendid submarine patrol fleet, consisting of motor destroyer type vessels of 700 to 800 tons displacement and about 17 knots speed, manned by efficient engine-room crews of naval-trained Diesel engineers, and by navigation officers conversant with submarine methods. Such boats probably could be armed with two 5-inch guns and machine guns, a 12-inch torpedo-tube and depth bombs, the absence of electrical propelling machinery and storage-batteries being a great advantage and would allow of better speed. Maybe it is not too late to do something with such submarines as are not actually laid down? However, it is, of course, for the Navy Department to decide whether the submarines are of more importance at the present time. We merely can suggest.

Some naval advisers consider 35 to 40-knot steam destroyers, and which usually are of about 1,100 tons displacement, are the best for submarine hunting, while others believe that speed is not so important as larger numbers of patrol craft, on the assumption that five hundred vessels of about half that tonnage and speed will give better and more effective service than two hundred destroyers, provided the great number of smaller destroyers can be built in the same period of time.

For instance, let us refer to Fig. 2. The space within the dotted circle (A) represents a patrol area in the war zone of 50 miles diameter allotted to the 35-knot destroyer (B); just where the enemy submarine, or submarines, will be lurking is unknown. We presume the freighter (C) will cross this area within a few miles of a predetermined course arranged by the allied navies, but it is doubtful if her time of passing a given position will be known by the destroyer within many hours or a day, so the freighter may cross at (D) while the submarine may be patrolling at (G) or 30 miles away. The submarine being at (H) starts to shell the freighter, which sends out a S. O. S. wireless. Instantly, the destroyer makes full speed for the scene; but, it takes her nearly an hour to arrive, the submarine has nearly an hour to complete her deadly and criminal work, and submerge before the destroyer can get near enough to attack her. This often actually has occurred in the zone. Sometimes the destroyer will make smoke which the submarine can see coming towards her.

Fig. 3 depicts the same patrol area given over to three Diesel-driven destroyers of 20 knots speed and of 500 to 600 tons displacement. When the freighter enters the area these patrols most likely would be in positions such as (M), (N) and (O), with the result that one (M) will be within ten miles of the freighter and her attacker. Consequently at least one of them will get to the scene of action quicker than will the faster and bigger steam destroyer, leaving the other two destroyers (N) and (O) free to dash around in the hopes of the submarine coming to the surface somewhere within the area, if the Diesel-destroyer (M) does not succeed in getting her. If these Diesel-destroyers are camouflaged the submarine may not see them when they are dashing at full speed to the attack, because they will emit no smoke, even at full speed, and will have no funnels.

In case of a dozen convoyed cargo-ships, which must occupy a large area because it is dangerous for them to keep too close, it is obvious that a dozen 20-knot Diesel-destroyers would be more effective than five 35-knot steam turbine destroyers, whose great speed is brought down to that of the convoyed vessels.

Furthermore, it would be a much easier job to maintain a fuel supply to the Diesel-driven vessels, even though there were many more of them, because three Diesel-engined destroyers would only need about one-third of the fuel-oil required by one big steam-turbine destroyer, and they would be able to keep the seas three times as long without re-fueling. This would relieve the oil-tankship service of a great pressure.

Let us also bear in mind the remarks made on December 15th, last, by Georges Leygues, Minister of Marine of France, who warned against too optimistic conclusions being drawn from reassuring developments. He said:

"We are ceaselessly working to counter the effects of the submarine war and have made genuine progress. We purchased a number of special high-speed, shallow-draft vessels to hunt submarines, and we are building a certain number ourselves. The German submarine campaign, while a grave, continuing danger, is partially checked. Still, however reassuring these observations may be, too optimistic conclusions should not be drawn."

Several months ago it was intimated in our columns that France had in service a number of 900 b. h. p. and 1,100 b. h. p. Diesel-driven destroyers, and more are being built. But, let the U. S. A. Diesel-driven destroyers, when they are built, be of two or three times this power and of real seaworthy size. Plenty of proven engine-designs that afford this power are available, from which our engineers can build.

Under normal weather conditions it is very much easier for the submarines to intercept steamships, than it is for the patrol vessels to discover the submarines. One reason is that freighters in traffic between America and Europe must pass east or west through more or less a fixed lane, although that lane may be many hundreds of miles in width, while the U-boats are free to move east and west a thousand or more miles, and north and south to the total width of the present wide transatlantic steamship lane. The latter means that the patrol-craft must constantly be cruising over an area of many thousands of square miles, while the submarines can remain at one spot until the smoke of freighters or patrol vessels is seen on the horizon, the distance of the horizon varying with the weather and roughness of the sea. Secondly, the submarines at times lie submerged, with only their periscopes above water, and even when cruising on the surface are by no means as conspicuous as a steamer, and rarely show any betraying smoke, excepting where her engineers carelessly have over-lubricated the machinery.

How easy it is for a small fleet of submarines to intercept every coal-fired ship that passes by them in daytime will be understood when it is realized that twelve submarines cruising abreast 40 miles apart from each other, and moving slowly east or west, effectively and continuously cover a transatlantic lane four hundred and eighty (480) nautical miles wide.

In bad weather their radius of vision will be reduced and so they must close-in towards the center boats, thus reducing the width of the lane covered by them. In calm and clear weather this

lane probably can be widened. It may be borne in mind that it is not necessary for the submarine to see the hull of a ship. When she sees a trail of smoke coming up from behind the horizon, it gives her ample time to cruise at the desired angle and head the oncoming ship off. When approaching within observation distance, she submerges and utilizes her periscope. If the vessel proves to be a freighter she will attack from the surface with her guns or fire a torpedo, in accordance with the judgment of her commander. Should the vessel prove to be a patrol-ship she probably will remain below the surface until it is safe to come up again.

This being the case it is easy to understand that if large numbers of camouflaged, mastless and funnelless, motor-driven freight and tank ships were engaged in the transatlantic service, Germany would need submarines stationed at least every ten miles north and south. In other words she would need a maintained fleet of fifty U-boats to effectively operate a lane 500 miles wide, instead of about twelve that she now needs, showing that the Shipping Board cannot have fully recognized the true value of the big Diesel-driven cargo and tank ships in this time of danger to commerce. But, before long they will do so, and that is why the Diesel-driven vessel will play a great part in this awful war, of which we have many years of terrific struggling before us.

CUTTING & WASHINGTON RADIO APPARATUS.

We have received a handsome little booklet from Messrs. Cutting & Washington, Inc., Cambridge, Mass., which deals in an interesting manner with wireless telegraphy in general, and with their own equipment. There are many valuable notes of information contained in this booklet and the following is an extract:

"The character and efficiency of the ground connection also materially affect the efficiency of a radio set. On wooden boats it is always necessary to place some sort of metal on the outside of the hull to establish a ground. We usually recommend from 300 to 500 square feet of copper in the form of a strip or plate connected to the radio room by a copper strip or wire. With steel ships it is necessary only to connect the ground wire to the hull of the ship. Any radio set installed on a certain size steel ship will develop more radiation and work farther than it will on the same size wooden ships—the steel hull forms the best possible ground connection."

"Two other very important factors to be considered in judging the distance a set will work are the character of the surface over which messages are sent and the time of day or night (and year) at which they are sent. Any radio set will send farther over water than over land; it will send farther over salt water than over fresh water; it will send about three times as far on the Pacific Ocean as on the Atlantic; it will send from two to ten times as far at night as it will during the day; and, in the temperate zones, it will send much farther in the winter than in the summer."

Copies of booklet can be obtained from Mr. J. P. Johnston, at their New York office in the Singer building. In an early issue we hope to publish an article on wireless telegraphy which Mr. William Fletcher of Cutting & Washington is specially writing for "Motorship."

INTERESTING MARINE OIL ENGINE DISCUSSIONS.

In connection with the New York Motorboat-Show several interesting discussions will be held at the headquarters of the Society of Automotive Engineers at New York City, on Friday afternoon, January 25th, 1918.

Mr. James Craig will give an address on "Developments and Improvements in the Diesel Engine in the U. S. A.," and Mr. E. A. Riotte, of the Standard Motor Construction Co., will talk on "Engineering Fundamentals in Low Speed Engines for Motor Boats." Discussions will follow.

In the evening a dinner will be held at the Automobile Club of America, after which several papers will be read, including one entitled, "Equipping Our Transports with Motorboats," by Mr. Erwin Chase of the Submarine Boat Corporation. Mr. Henry R. Sutphen of the same company will speak on "Standardization of Boat Construction," and movie pictures will depict coast patrol boats and submarine chasers.

AUXILIARY SAILING-VESSELS IN EUROPE.

In Europe alone no fewer than sixteen sailing-ships of over 200 tons d. w. c., and aggregating 17,070 tons, have been fitted with Bolinder marine oil motors totalling 3,240 b. h. p.

The Importance of Petroleum Products

By VAN H. MANNING,
Director U. S. Bureau of Mines.

THE average person fails to realize the importance of petroleum and its products in the ordinary routine of the world's work, yet every man, woman, and child in America is dependent in some measure upon petroleum and natural gas. There is scarcely a phase of our national life in which we do not find petroleum products used—they drive our battleships, deliver our merchandise, pull our trains, heal our wounds, color our garments, smelt our ores, carry our mails, cook our meals, and increase our knowledge of the outdoor world. They illuminate the magazine we read and the book we study; they carry us home from the office, and make chewing gum for the children.

Every industry makes some use of petroleum or its products, and to list all of the uses would not be feasible here. It is sufficient to say that petroleum is essential to the commercial development of the country, and that if our supply were cut off today, our industrial progress would be brought almost to a standstill. It has been said that when petroleum is gone, electricity will take its place, but, although electricity will furnish power for our industries and lights for our homes, it will not lubricate even the machinery needed for its own generation.

The Navy is dependent on the petroleum industry not only for lubricating oils but to an increasing extent for fuel. Battleships that use oil as a fuel can carry larger armaments, and have a greater range of action than those that use coal. Petroleum is thus vital to our national defense and perhaps to our national existence.

Limitations of Supply of Petroleum.

What shall we do when our supplies become depleted? Although this country has large known reserves of petroleum, these supplies are limited. At our present rate of consumption our estimated supplies are sufficient to meet our present needs for a comparatively short period, conservatively estimated to be from 25 to 30 years, taking no account of the increasing demand for petroleum and its products. This estimate not only includes the oil fields already known and developed, but makes liberal allowances for undiscovered fields in prospective oil territories. It should not be thought that our petroleum supply at the end of that period will be cut off abruptly, for the wells will continue to produce through a declining output for many years. On the other hand, the shortage of petroleum is beginning to be felt now. A good measure of the accuracy of these estimates, which were made more than a year ago by the Department of the Interior, is the result of the search for oil the past year. Owing to the demand for crude oil, more territory was prospected and more wells were drilled in search of petroleum in the Mid-Continent field than in any previous year. During the year 1916 there were approximately 15,000 wells drilled in that field, as compared with 6,000 wells drilled in 1915, yet the production today will not equal that of two years ago, in 1915, nor have any large new oil fields been developed.

What effort have we made to conserve this supply and to utilize it to its greatest advantage? We have made little effort until very recently to do these things. We have been wasteful, careless, and recklessly ignorant. We have abandoned oil fields while a large part of the oil was still in the ground. We have allowed tremendous quantities of gas to waste in the air. We have let water into the oil sands, ruining areas that should have produced hundreds of thousands of barrels of oil. We lacked the knowledge to properly produce one needed product without overproducing products for which we have little need. We have used the most valuable parts of the oil for purposes to which the cheapest should have been devoted. For many years the gasoline fractions were practically a waste product during our quest for kerosene; with the development of the internal-combustion engine the kerosene is now almost a waste

product in our strenuous efforts to increase the yield of lighter distillates. [The recent more general use of the marine oil engine considerably relieves this situation.—Editor.]

This country is producing about two-thirds of the world's output of crude petroleum and has produced approximately 2,750,000,000 barrels since the drilling of the first oil well by Col. Drake in 1859. Our future supply from both proved and prospective oil fields, based on geological possibilities, is estimated to be approximately 7,402,000,000 barrels, which will last us only about 25 years at our present rate of consumption. We are exporting 20 per cent of our production, **using approximately 25 per cent as fuel under boilers,** and of the remainder probably one-fourth is wastefully utilized. Thus 70 per cent in all is being used in a manner that must be considered anything but conservative for so valuable and so scarce a product.

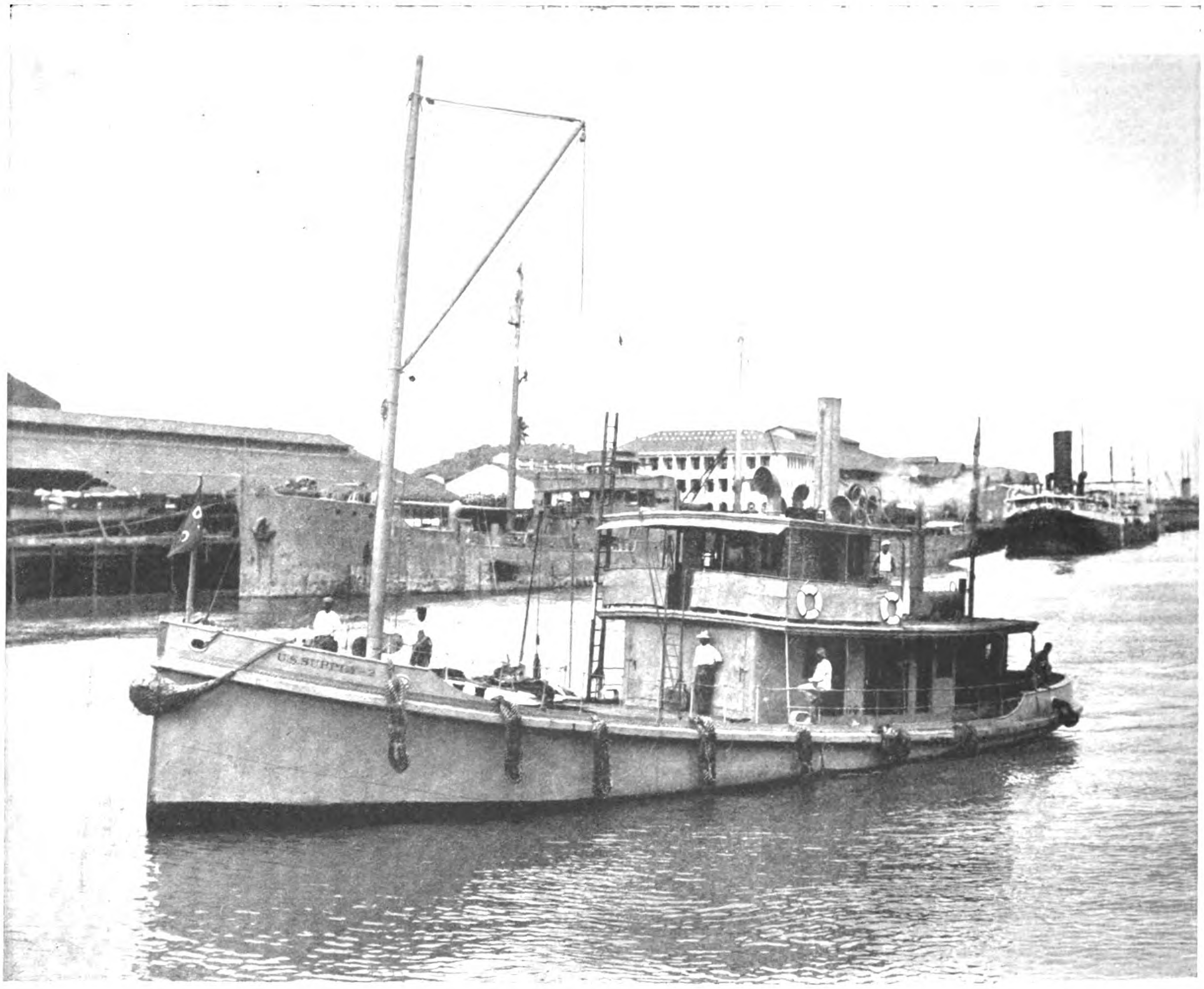
As an example of wasteful utilization, a large proportion of our artificial gas is made from petroleum, notwithstanding the fact that coal has been and is used for this purpose, and would be used altogether except for the reason that the gas manufacturer is able to buy petroleum cheaper. At the present rate of production it is estimated that our coal supply is adequate for many centuries. Clearly we should not use our petroleum for fuel under boilers or for gas manufacture, or in any way to compete with coal, when the oil supply is so limited. * * * * * *

Extraction of Oil From Oil Shales.

The question is being asked daily what this country is going to do when our petroleum resources are exhausted. We have as yet untouched our great reserves of shales that contain oil. These shales are found in many parts of the United States, and tremendous reserves are known in Colorado, Utah, and Wyoming. There is only one country in the world where oil shales are being utilized for the production of oil—Scotland, where little petroleum occurs and where the demand for petroleum is great. Some of our shales are much richer in oil than are the Scotch shales, and are conservatively estimated to contain many times the amount of oil that has been or will have been produced from all the porous formations in this country.

To obtain the oil from oil shale it is necessary to heat the shale in great retorts. The oil is the result of destructive distillation and is driven off in the form of vapor and is later condensed by cooling. As stated above, this process has never been used in this country because of the lack of necessity, for our oil reserves are great, and it would not be commercially economical to invest money in retorts for distilling from oil shale oil that would have to compete with the crude oil obtained by other methods. But this condition will not last forever. In fact, it is thought that it will be only a very short time until the oil-shale industry will be one of magnitude.—From the Year Book of the Bureau of Mines.

Two Diesel-Engined Supply Boats for the U. S. Government

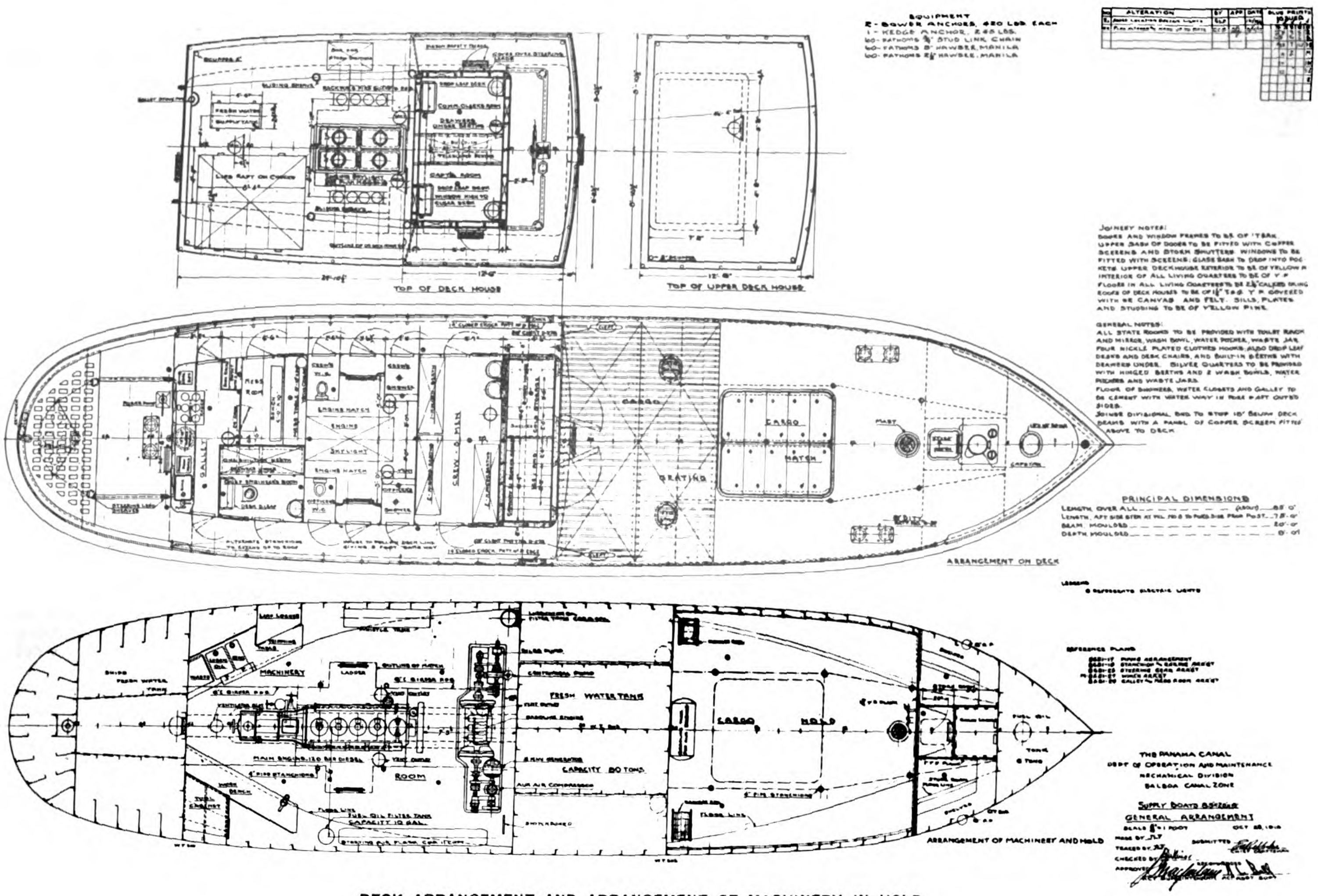


U. S. DIESEL-DRIVEN SUPPLY BOAT No. 2

We are enabled to reproduce through the courtesy of the Executive Department of the Panama Canal photographs of the two Diesel-driven supply boats, recently placed in commission at each terminal of the Canal. In the October issue of last year we printed a description of these boats. As will be remembered from this description the boats were designed and built at the Balboa shops of the Canal and are primarily for the purpose of conveying supplies to vessels lying in the roadsteads or outer harbors at Balboa and Cristobal. They also serve as light tugs when needed. The cargo hold of each boat has a capacity of about 20 tons, and rigging on the forward deck handles the loading and unloading of the cargoes.

The dimensions of the boats are as follows: Length over all, 85 feet; length on the waterline, 75 feet; beam, moulded, 20 feet; depth, moulded, 9 feet; designed draught, 5 feet 6 inches; displacement, 140 tons. The forepeak is used as a fuel-oil tank, with a capacity of 6 tons of heavy oil. The engines consume less than a gallon of fuel per mile, and the boats have a cruising radius of 2000 miles. Abaft the forepeak is the chain locker and hatch to the storerooms, port and starboard; these storerooms are available for storing small articles such as tobacco, cigars, soap, men's outfits, miscellaneous supplies, etc. The cargo hold has a capacity of about 20 tons and will store provisions in crates to be sold to vessels. A fresh water tank of 50 tons capacity, built between the machinery space and the cargo-hold, will supply fresh water to vessels. In addition to this main tank the after peak is arranged as a water tank with a capacity of 20 tons, and is piped so the two tanks can discharge water to each other or to vessels alongside.

The propelling power of these vessels is fur-



DECK ARRANGEMENT AND ARRANGEMENT OF MACHINERY IN HOLD

nished by four-cylinder, four-cycle, heavy duty reversing gear type Nlseco Diesel engines developing 120 b. h. p. at 350 r. p. m. This engine was built by the New London Ship and Engine Company of Groton, Conn., and weighs approximately 20,000 lbs. The cylinders are 9" bore and 12½" stroke. A few of the dimensions of these engines are as follows: Length, over all, 18 feet; width, 3 feet; height, 7 feet; diameter of the fly-wheel, 47"; weight of fly-wheel, 1200 lbs; diameter of the crankshaft, 5¼"; intermediate shaft diameter, 4¼"; thrust shaft diameter, 4¼"; propeller shaft diameter, 4¾". The speed of the pumps are as follows: Fuel pump, 175 r. p. m.; mechanical oiler, 434 r. p. m.; lubricating oil pump, 490 r. p. m.; rotary circulating water pump, 408 r. p. m.; auxiliary air compressor, 300 r. p. m.

In the period during which these boats have been in operation, about five months, the charges for material used, outside of subsistence, has averaged about $230 per month. A detail of engine costs for one of the boats for one month was as follows:

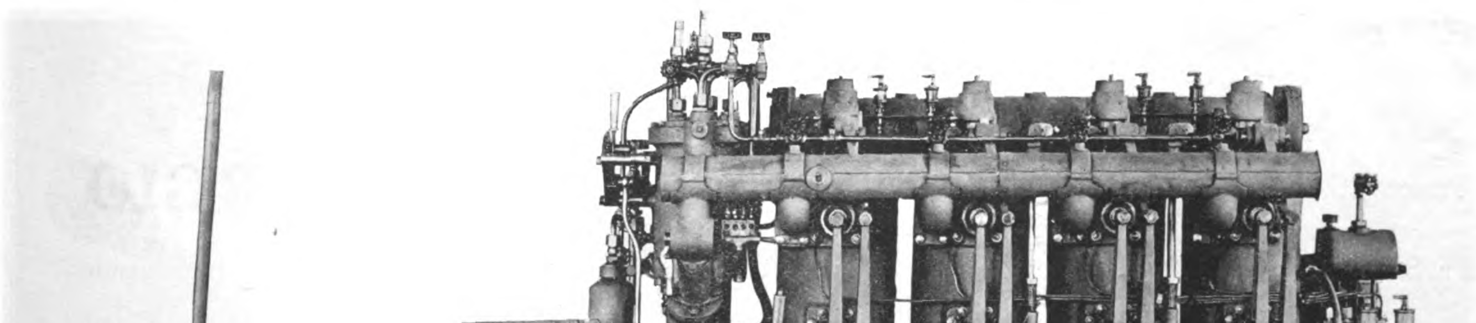
17 barrels of Diesel oil at $3	$51.00
30 gallons Monogram oil at 53 cents	15.90
3 gallons compressor oil at 22 cents	.66
5 gallons kerosene at 13 cents	.65
Total	$68.21

The operating hours of the main engine were 175; the average cost per hour was thus $0.39.

The auxiliary engine used in the same month:

71 gallons of gasoline at 29 cents	$20.59
5 gallons Monogram oil at 53 cents	2.65
Total	$23.24

The operating hours were 30, and thus the cost of operating per hour was $0.775.



120 NLSECO ENGINE INSTALLED IN U. S. SUPPLY BOATS

Rear-Admiral Chester M. Colby, U. S. N. (Retired), Advocates Motor-Driven Ships

DISCUSSING the utilization of America's inland waterways, Rear-Admiral Chester M. Colby, U. S. N. (retired), says, among other things:

"In a report to the National Rivers and Harbors Association, whose representative I had the honor to be, at a large international congress of navigation, held at Petrograd in June, 1908, after making a protracted trip down the Volga River, studying 'commerce makers,' I wrote a report to that organization on the subject of motor vessels engaged in the foreign commerce of the United States, which was published in the proceedings of the society for 1908, and later, in an address before the Atlantic Deeper Waterways Association at New London, on September 5, 1912, I said as follows:

"'I look forward to the day when bulky articles of commerce manufactured at Gary, in Indiana, let us say, may be shipped, without breaking bulk, in specially constructed barges of about 2,000 tons burden, drawing from eleven to twelve feet of water, and propelled by gas engines, proceeding via the Erie Canal and the Atlantic interior waterways to and across the comparatively peaceful waters of the Caribbean Sea, to the Panama Isthmus, and thence to the great markets of the western ocean. Such a class of vessels as would be suitable for this trade may be fitted with sail power, carried on masts that can be lowered when passing under bridges or other obstructions, but which, upon being raised again, may be used to economical advantage on the Caribbean Sea, where favorable winds prevail, or on any other open water spaces of the long Canal Zone.

"'**As an argument for the construction of such a class of vessels** as I have suggested I would call attention to the fact that today **the largest part of the British foreign trade is shipped on small low-power steamers known as 'tramps,'** manned by a small force of men, and travelling at slow speed, thereby economizing in manual and mechanical labor. They do not run on established routes of trade, but proceed to any ports of the world, where it may be necessary to call in order to deliver their cargoes direct in the shortest space of time from manufacturer to consumer. **It is these ships, and not the leviathans that carry passengers and fast freight, that give to Great Britain her commercial supremacy.** They bring into her treasury large profits as a result of their voyages, while the palatial steamers fitted up for the travelling public, on the other hand, pay but small interest on the money invested, and even the bulk of these dividends is drawn from subsidies furnished by the government in order to be able to control the services of the ships for naval purposes in time of war.'

"Mr. Edison has recently made a timely suggestion that the large fleet of sailing ships which cannot at the present time be utilized in our foreign trade be at once converted into motor-boats and used in the transportation of supplies to our allies and our own people 'over there.' One of the cheapest and best transportation services in the world is that carried on by fore and aft rigged sailing craft that now are largely engaged in our coastwise trade. If such craft, of about 2,000 tons capacity, drawing not more than twelve feet of water, were fitted with gas engines which can be run by almost any Yankee boy of average intelligence, thus saving the expense of employing high grade and high paid mechanics, they would be able to load articles of heavy bulk which will not pass through the tunnels of the American railroad system, and carry cargo from Duluth, Chicago, Detroit and other inland cities to their destination in any part of the world, without breaking bulk. This at once eliminates the heavy port charges and transhipment expenses at New York, already congested beyond the danger point, to the great advantage of both producer and consumer. The masts of such vessels may be whipped out and laid on their decks before entering the canals, to enable them to pass under low bridges, and restored to their places in a 'jiffy' to make ready for sea again.

"Perhaps, now that necessity, which is not only the 'mother of invention' but the 'father of reform,' creates a demand for the utilization of our interior waterways that suggestion will bear fruit."

We have not previously seen the address made years ago by Rear-Admiral Colby before the Atlantic Deep Waterways Association, but that our beliefs are very much the same is indicated by the following extract from the editorial-leader in Motorship for November last:

"Look what an enormous advantage this means to the 'tramp' class of steamships! Much of the British enormous pre-war overseas trade was due to the tramp class of ship, which could not have been unless assisted by Great Britain's world-wide coaling depots. American motorships carrying their own fuel supply in the double bottoms will 'beat the British tramp to it.'

"At present Great Britain is not a competitor with the United States in the carrying of freight on the ocean, because there is more freight than vessels to carry it; so America's policy now resolves itself mainly into a matter of 'ships.' When Great Britain had her great merchant fleet intact freight rates were low, and so they will be again as soon as Great Britain has sufficient ships to compete once more with the world."

It is with pleasure we see such an eminent and experienced authority as Rear-Admiral Colby advocate motorships, and no doubt his opinion will receive due consideration from the powers that be, especially because since 1912 the marine-internal-combustion engine has made such great strides, and it is now possible, and advisable, to use crude-oil engines, or even producer-gas motors, instead of gasoline motors, as mentioned by him at that time.

BUNKER COAL AT SUEZ.

Today bunker-coal costs $60 per ton at Suez, and correspondingly high prices at similarly situated ports. This is equivalent to over $250 per ton for oil-fuel for a Diesel ship, whereas oil-fuel in America only is about $12 per ton.

THE POWER OF THE ZEPPELINS.

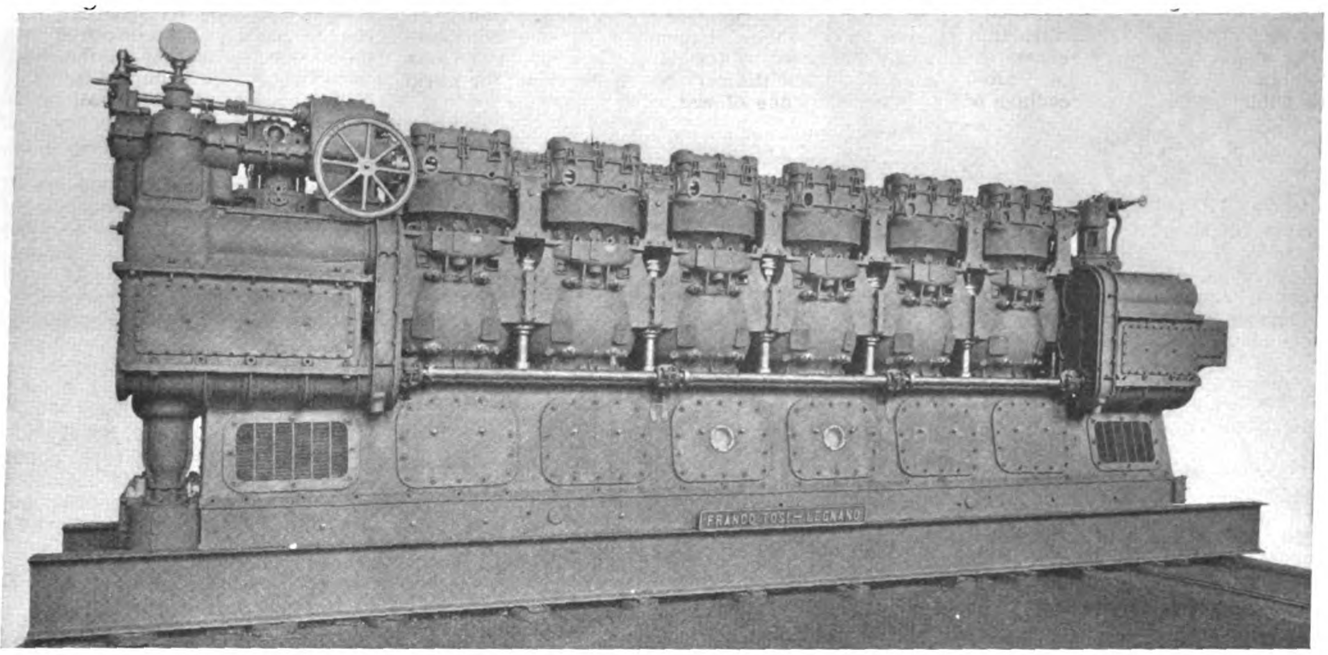
According to the reports concerning the big German zeppelin, which fell down in France during October and was captured intact, it is propelled by a twelve cylinder Diesel-type oil-engine. The length of the balloon part of the airship is about 600 ft.

High-Powered Submarine Diesel Engines

LAST April "Motorship" published drawings, photographs, and technical details of most of the submarine-Diesel type engines of the World's navies including those installed in the German U-boats. It was shown in this article how several European navies already have in service twin-screw submarines of nearly 5000 brake-horse-power (2500 b. h. p. per shaft), which is a remarkable development compared with what has been done with submarine engines in this country, and we have every reason to believe that before long we shall, by consent of the Allied powers, be able to give illustrations of one or more, of the giant Diesel engines, of these boats, and thus reveal to engineers and shipowners what wonderful strides have been made during the war with the marine oil-engine across the Atlantic. This disclosure is bound to give great and desirable impetus to the Diesel engine in this country.

Already the curtain has been lifted in the case of one of the navies of our allies, and we now are enabled to give some illustrations of large submarine Diesel engines built by a great Italian company. Permission was withheld at the time of the publication of our first article last April. The larger of the two engines in particular will be of considerable interest because it is a splendid example of modern marine oil-engineering work. One noteworthy feature is that the builders of these Diesel engines are important marine and stationary engineers, as well as being Diesel engineers, and have constructed marine steam turbines up to 24,000 h. p. per shaft. We refer to Franco Tosi of Legnano, Italy.

Both Tosi-Diesel engines are six-cylinder sets, but the larger is of the two-cycle type, and the smaller operates on the four-cycle principle, but both are single-acting. The two-cycle engine is reversible and has an output of 1300 brake-horse-power, or equivalent to about 1700 indicated h. p., at 300 r. p. m., and is capable of running continuously when developing about 12 per cent more than this power, so is a very powerful engine. Two of them will give a 900-1000 ton submarine a speed of about 18-19 knots, making a very formidable war-craft capable of operating with the Grand Fleet under some conditions, and capable of crossing the Atlantic without convoy.

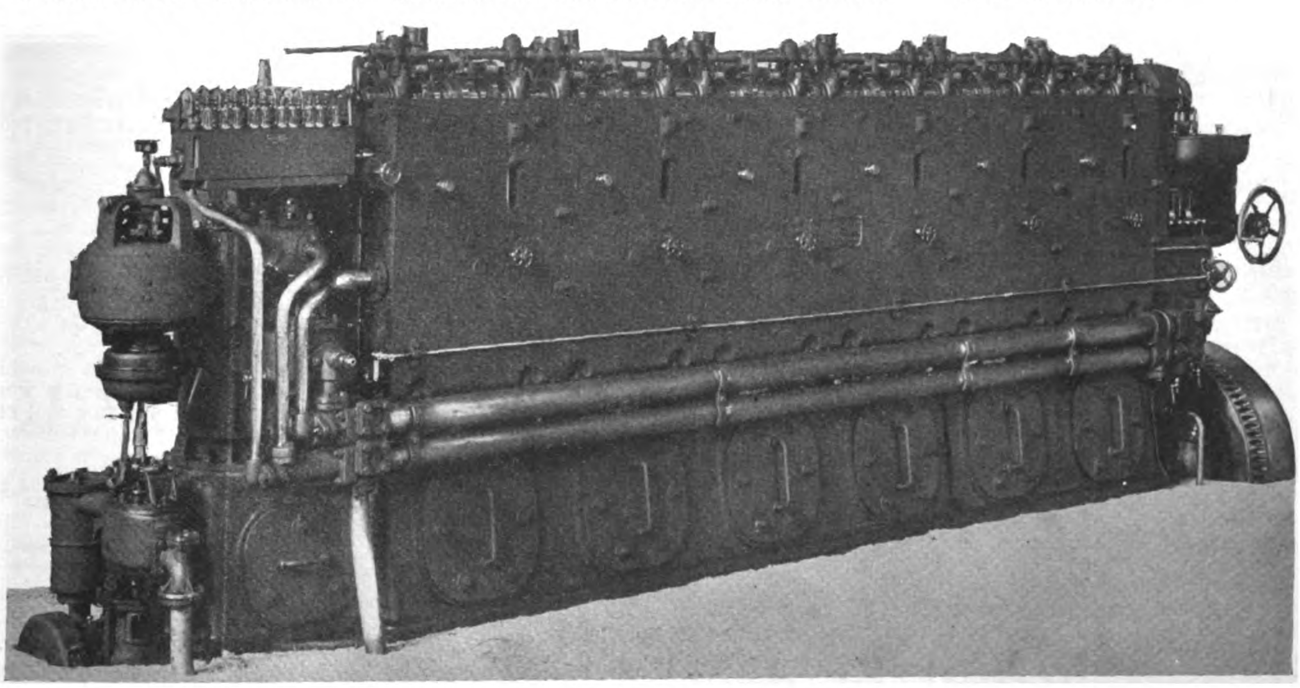


THE TOSI TWO-CYCLE TYPE 1300 B. H. P. DIRECT-REVERSIBLE SUBMARINE DIESEL ENGINE. TWO, OR THREE, OF THESE MOTORS WOULD FORM IDEAL POWER FOR A LARGE SUBMARINE DESTROYER

In design this engine is one of the neatest and cleanest ever built and a control is by a single hand-wheel. It is direct-reversible. At each end is a scavenging-pump, which furnishes air at a few pounds pressure for the port-scavenging system. There is a four-stage compressor with a complete cooling system. The working cylinders of the engine are of a special cast-iron, and are mounted on a box-frame of cast steel. Two, or three, of these 1300 b. h. p. Diesel engines, wou'd form ideal power for submarine destroyers of about 800 tons especially as it is direct-reversible.

It has been found that with these new submarines direct-reversing with its attendant mechanism are entirely unnecessary, as these Diesel engines are installed aboard craft, which must have a complete electric propelling outfit for the running under water, so starting and reversion of the engines is made by means of the electric motor on the main shaft, and the direct-reversing mechanism is not used in actual submarine practice, but is locked.

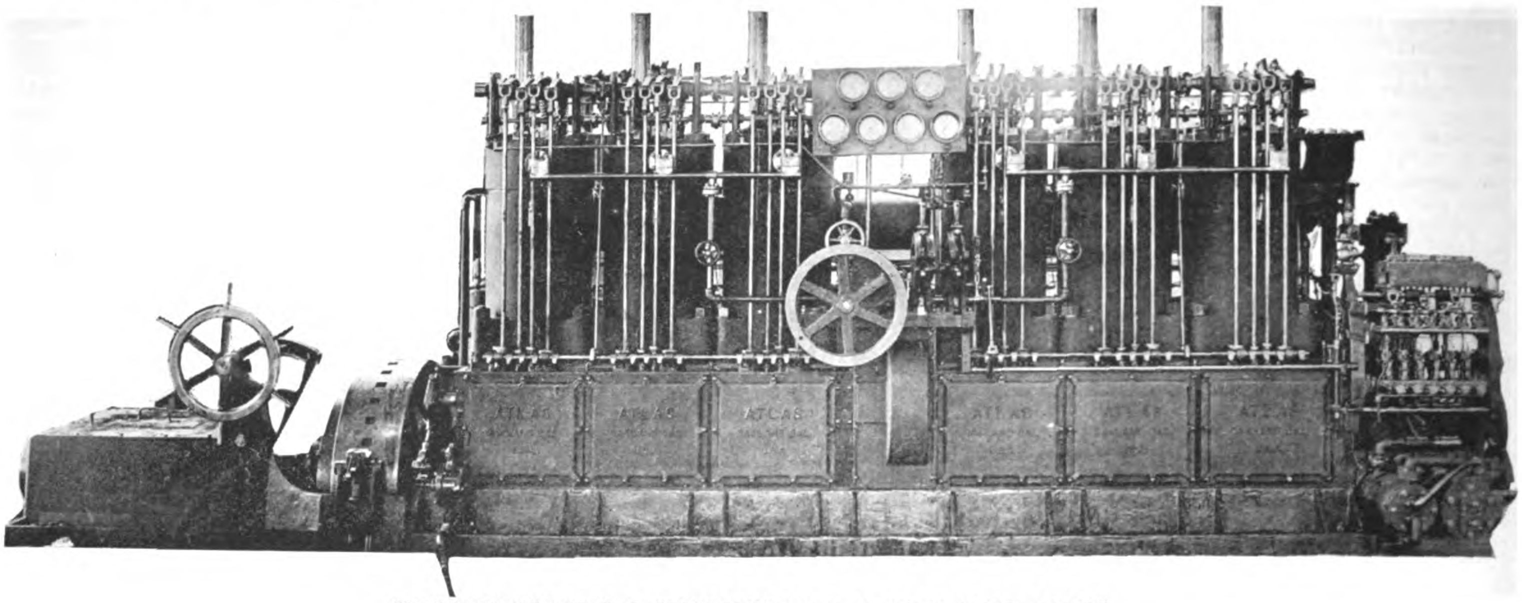
The long operating and service period of the submarines during this war have demonstrated that engines with electric reversing mechanism have done excellent work, and has resulted in the smaller engines dispensing with the mechanical-reversing mechanism, thus producing a much simpler and lighter engine. This practice has been adopted for new engines for many of the Allies' submarines.



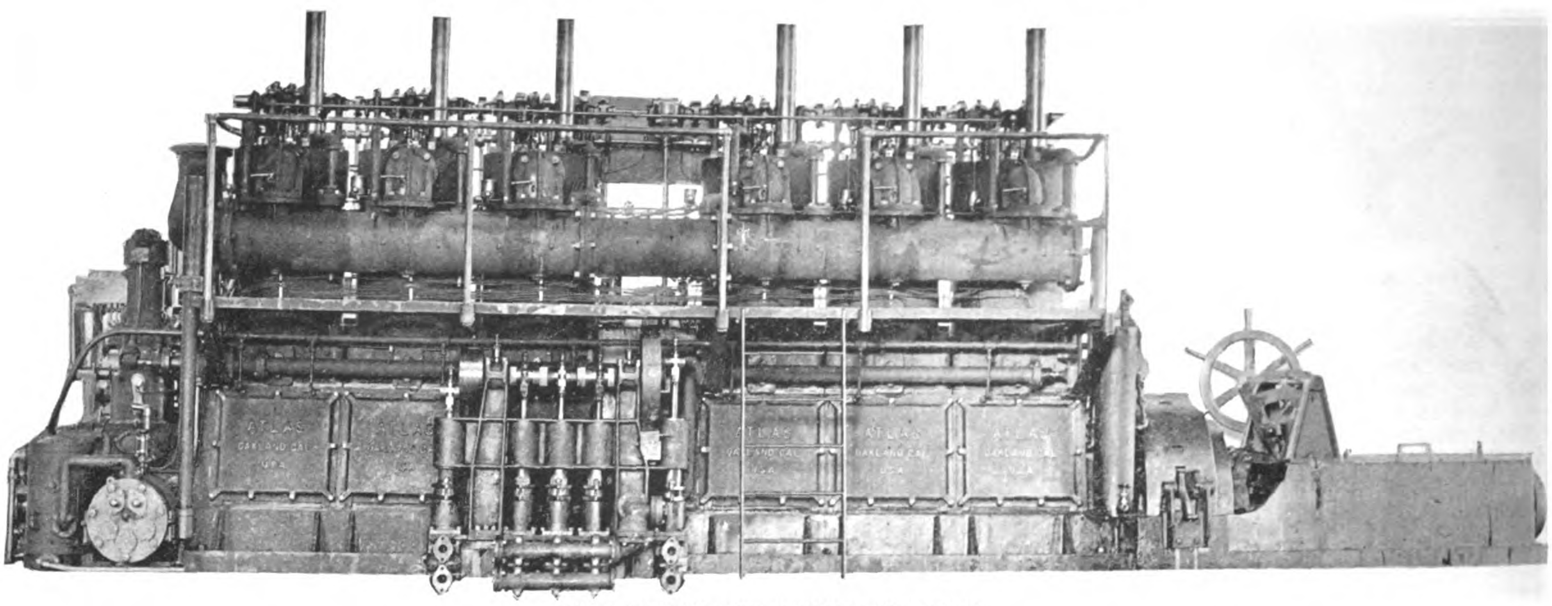
THE TOSI 400 B. H. P. FOUR-CYCLE TYPE SUBMARINE-DIESEL ENGINE

The Tosi four-cycle 400 b. h. p. submarine engine also has 6 cylinders, but is built without mechanical reversing mechanism, but with electric-starting and electric-driven water and oil pumps, and the engine runs at a normal speed of 450 r. p. m. The electric pumps are at the forward end of the engine and are arranged in a manner that we never have previously seen, being a new feature of Diesel-engine design. These engines have been built in many sizes for the Italian navy and have given very satisfactory results.

Atlas Diesel Engine of 350 Horse Power for M. S. "Bowler"



OPERATING SIDE OF M. S. "BOWLER'S" 350 H. P. ATLAS DIESEL ENGINE



PORT SIDE OF THE "BOWLER'S" MOTOR

THE above photographs are those of the 350 b. h. p. Atlas Diesel motor built by the Atlas Imperial Engine Co. of Oakland, Cal., en route to Vancouver, B. C., where it is to be installed in the M. S. "Bowler" ex S. S. "Zafiro." The dimensions of the engine are as follows: Number of cylinders, 6; bore, 12½"; stroke, 16"; length of engine over all including thrust block 24'; height above center of shaft, 7'; width, 4' 6"; diameter of crankshaft, 7¼"; propeller diameter, 100"; propeller shaft diameter, 7½"; net weight, 36 tons; weight of auxiliary and equipment, 14 tons; actual b. h. p., 375.

THE ENGINEER QUESTION.

We cull the following from an editorial leader from "The Daily Marine Record" of New York, entitled, **Future of American Shipping.**

"Another urgent question is the issuance of seagoing certificates for engineers capable of running Diesel or semi-Diesel engines.

"At present, the law demands that a sea-going engineer—no matter whether the engines are of the internal combustion type or steam engines—must have a certificate based on the experience of a steam engineer. The law might as well order that every chauffeur should be a certified cab driver.

"The result of this anomoly has been that many valuable vessels with internal combustion engines have proved a failure, and that an important invention, which is particularly adapted to this country, is being brought into disrepute owing to these failures.

"But, the chief reason why American overseas shipping is comparatively undeveloped as yet is the entire lack of a national association of shipowners and the absence of unified action in connection with the disabilities just recited."

AMERICAN-BUILT MOTORSHIP FOR ICELAND.

Among American built motor-driven auxiliaries not previously referred to in this journal is the "Stjarnan," built by F. F. Bingham of Pensacola, Fla., for Thorsteinsson of Reykjavik, Iceland, and fitted with twin, three-cylinder 8½"x10" Fairbanks-Morse surface-ignition type marine oil-engines.

CLARK DUBBING MACHINE.

A new machine which will find immediate favor among wooden shipbuilders has recently been placed on the market by G. C. Clark of Everett, Wash. It is used in sizing the frames or properly speaking is a dubbing machine, driven by electricity. One machine is already in use at the plant of the Tacoma Shipbuilding company of Tacoma who, in a letter to the inventor, state that it has been thoroughly tried out and that they find it satisfactory in every way, that a much truer job is made by it than by the hand method now in use at one-quarter the expense and a great saving of time. They state that it has met every requirement and that in a test covered, 758 sq. ft. in four hours. Full particulars will be given in the February issue of Motorship.

NEW CANADIAN MOTOR SCHOONER.

The 3-masted motor-auxiliary schooner "Ruby" of 300 tons d. w. c. was launched on the 10th of November, at the yard of the Nova Scotia Shipbuilding & Transportation Co., of Bristol, Nova Scotia, to the order of Captain Walter Wrightson, of Mobile, Alabama.

This vessel has a keel length of 118 ft., a breadth of 33 ft. with 12 ft. depth of hold. There will be installed aft an auxiliary oil-engine, while forward there will be a small gasoline engine, operating a cargo-hoist. We understand that the same builders have under construction a 3-masted schooner for Australian owners, and have a couple more ships under construction for local owners.

A WONDERFUL OIL WELL.

Gasoline for the Allied flying corps is now obtained from a wonderful oil well which the Royal Dutch Shell recently struck in Sumatra. This oil contains 54% very light gasoline, which is the finest quality known in the whole world, states Sir Marcus Samuel. The well started flowing on May 5th last, with a tremendous output and still is delivering two hundred thousand gallons of oil each day. As the well is in new territory its life is expected to be a long one. The gasoline obtained, being devoted exclusively for aeroplanes, is not available for public consumption.

BUFFALO INSTALLATION.

C. W. Cook, of the American-Hawaiian Steamship Co., San Francisco, has had his motor cruising launch "Loon" at a shipyard undergoing some alterations. A 30 h. p. Buffalo gas engine has been installed by the Columbia Machine Works and the craft has been generally overhauled. The "Loon" is a full-cabined cruiser 45 ft. in length by 10 ft. 6 in. in breadth, with a draught of 40 inches. With her new engine the "Loon" is expected to make a speed of 11 miles in any weather encountered on the bay.

TEST ON FULTON DIESEL ENGINE.

A fuel consumption test was recently made on a Fulton Diesel engine of 50 h. p. The fuel used was Pennsylvania fuel oil and the consumption worked out at 0.5025 pound per h. p. hour, which is very good results for an engine of such low power.

Submarine Hulls

Comments on Various Types

By NAVAL CONSTRUCTOR E. S. LAND, U. S. N.,
Member Society of Naval Architects and Marine Engineers.

THERE has always been more or less controversy with regard to the proper type of submarine hull; the subject is unsettled to this day and will probably remain so for many years to come, for submarines are still in the infancy of evolution. Many are the claims advanced as to the original submarine inventor; many and fantastic were the early designs; yet in this, as in the majority of things in this world, it is safe to award the palm to Mother Nature, for she designed the salmon. A casual examination of this interesting fish will show that, so far as hulls are concerned; the contour of the salmon makes a rather good model for a submarine. Combining the model laid down by nature with the imagination and second sight of Jules Verne, we have the submarine of yesterday, today and tomorrow.

Without taking up the early designs with which you are undoubtedly familiar, it is my desire to present, in a crude way, the merits and demerits of the types of submarine hulls as they are in evidence today. They align themselves into two distinct types—single hull and double hull. However, there are intermediate types that merge on the one hand to the strictly single hull, and on the other hand there are some types in which the double-hull features predominate. Recently there have been developed several types which are practically mid-way between the single and the double hull. These are known as saddle hulls.

Of the pure single-hull type the best known is the Holland type, which predominates in the American navy today and of which there are many examples in other navies of the world.

The double-hull types are well represented by the Laubeuf designs and the Krupp-Germania designs. Of the various types of German boats, some are single hull and some double hull, depending primarily upon the size of the boats and the purpose for which intended. The Krupp-Germania design was evolved to a considerable degree from plans prepared by the French engineer d'Equevilley. Many good features of other types were taken by the Germans. The Laurenti design is generally considered as a true double-hull design; it is not, however, a complete double-hull boat, but is composite in that it is part double-hull and part single-hull construction.

The saddle hulls are more common in the British navy and may be considered more as a development from the Holland design than from any other.

The Lake design, with its watertight superstructure, is properly a single-hull design, but on account of this watertight superstructure feature it is not a pure type of single-hull.

The Hay-Denny design, which is well known in Denmark and Holland, belongs to the composite type, combining features of both the single and the double-hull type. Certain parts of the vessel are single-hull construction and other parts are double-hull construction.

There are probably more variations in the single-hull type in the British navy than in any other navy today, and these modifications run from the small sponson on either side of the strength hull found on some of the earlier British boats to the real saddle tanks found in the more recent designs, which types approach the pure double hull.

"For submarines, where a good relation between length and breadth is necessary, the cylindrical shape is best, with circular cross-section, diminishing towards the bow and stern and closed off at the ends with a rounded plate. For strength of construction it is necessary that the weight of hull be about 58 per cent of the total displacement, whereas with torpedo-boats, for instance, only about 38 per cent is necessary. In addition to the above, it is necessary to give the boats a relatively greater draught than other craft, and this mitigates against the attainment of great speed on the surface. In about the middle of its length the submarine has a strong tower, which serves as a steering hood and control station."

No matter which type is investigated, the same underlying features generally obtain in all of them, namely, there is one strength hull, the inner hull, which is constructed so as to successfully withstand deep submergence; outside of this strength hull there is generally fitted a superstructure of light plating and light scantlings. This may be non-watertight as is customary, or watertight as in some Lake designs, or partially watertight and partially non-watertight. The non-watertight space between the inner hull and the strength hull is generally utilized for stowage purposes, to house piping, ventilation ducts, towing lines, mufflers, cables, etc. The watertight portions are utilized for stability purposes, reserve buoyancy and seaworthy qualities. In some types torpedoes are stowed and torpedo tubes are installed in the superstructure but there are many serious drawbacks to this method of installation and service experience is generally very much against their satisfactory use.

It is understood that the first sponson type of submarine was so constructed from single-hull types to improve the stability of the boats, this being done as an alteration late in the period of construction or after the boats were in service. With this as a beginning, this type was developed so that it appeared in the original design not only for stability and seaworthy qualities but also to permit the installation of broadside torpedo tubes, external ballast tanks, or even oil tanks.

The design of submarines, unlike the design of other vessels of war, has never gotten beyond the stage of having somebody's name attached to it and, like everybody's watch, the type bearing the particular name is the only correct type according to the designer's opinion. Probably, like the watch, this is approximately true if you apply the correct "equation of time."

In discussing the question of types of hull, it is preferable to analyze as far as practicable the merits and demerits of the pure types, i. e., the single and double hull. If one attempts to cover the intermediate types, the argument is either confused or entirely lost, as in the nature of things these intermediate types partake of the advantages and disadvantages of both in a relative degree, depending upon which type the intermediate most resembles.

It is well to indicate here that any discussion of types and development of types will be given in a general way without any attempt being given to go into details which might be considered in any way confidential. Neither should the statements be construed as a criticism of or advocating any particular design. Accurate information relative to details of submarine construction is difficuilt to obtain. It has always been more or less enshrouded in a veil of mystery—probably very unjustly and very unnecessarily so.

It seems likely, because the main operations of a submarine take place out of sight, that the average man enjoys carrying out this water veil of secrecy and invisibility to rather absurd extremes. Be that as it may the tendency to deep secrecy still obtains and information that may be available is not permitted to be published, though a careful examination of all the chaotic literature on submarines will readily show that the so-called secrets of submarines are like the old maid's secret, "yours for the asking." Possibly, like some well-known breakfast foods, "There's a reason."

For the sake of clearness, it may be well to advance the arguments of one side and then the other, placing them in juxtaposition. In order that the advantages and disadvantages of single hulls and double hulls may be considered, the following comparisons of the two types of construction are made. These comments contain some of the arguments advanced by the builders of the different types of boats, as well as additional comments relative to the merits and demerits of the two types. As might be expected, the points at issue are subject to differences of opinion.

Deck Space And Freeboard.

Double Hull.—Increased deck space and deck height, which provides some means for the crew to get a little fresh air, and a small amount of exercise; this increases the habitability factor of the boat. Habitability is a vital factor in a sea-keeping submarine. Efficiency of personnel is directly dependent upon this factor.

Single Hull.—The type of vessel does not necessarily affect either the width of the superstructure or the deck height; the single-hull design can be arranged to give the same results in this respect as the double hull type of vessel. In some standard designs the width is practically the same for both types.

Strength.

Double Hull.—Since all diving tanks are outside the pressure body, the inner hull has a smaller diameter and greater strength.

Single Hull.—Double-hull boats are usually designed for about 150 feet depth test (foreign requirements) and single-hull boats for 200 feet. As far as it can be calculated, the margin of safety in single and double-hull boats is the same; if there is any difference it is probably in favor of the single hull.

As actually built the steel weight for a double-hull boat of 150 feet depth test is approximately the same percentage of light displacement as that of a single-hull boat of 200 feet depth test. In other words, for the same strength, the double hull is heavier.

Form, as Affecting Surface, Speed and Seaworthiness.

Double Hull.—Better stream lines are possible; hence, less resistance is offered to surface propulsion, and a more seaworthy boat can be obtained.

Single Hull.—Up to a speed of about 16 knots for boats of 800 tons or 14½ knots for boats of 500 tons single-hull models drive easier than the double-hull models. The present single-hull models are designed for moderate speeds and the double hulls for high speeds. It is the opinion, however, that the difference as noted above would still obtain but in a lesser degree, with single and double-hull boats each specially designed for the same speed. Structural and space requirements usually prevent the use of a small longitudinal coefficient in a double-hull design, so that a practicable double-hull boat probably cannot be made to drive as easily as the single-hull at moderate speeds.

As regards sea-worthiness it is considered that single-hull designs have proven that they are seaworthy, in fact very much more so than some designs of the double hull type.

Fuel Tanks.

Double Hull.—Fuel tanks may be installed outside the strength hull, giving greater capacity for fuel, hence greater cruising radius. As these outside fuel and diving tanks have their pressure equalized with the outside water pressure, they can be blown out much quicker in case of an emergency, and greater reserve buoyancy obtained quickly.

Single Hull.—There is no choice between double and single hull in this respect. Fuel can be carried in ballast tanks of single-hull boats as well as in double-hull types. The question of fuel being "outside the strong hull" is not material since the inner wall of the ballast tanks in the single-hull boat is tested to the same pressure as the hull itself.

In the single-hull type the internal walls of ballast tanks are tested to the same pressure as the hull itself, and the main tanks are therefore capable of being blown at any depth which the hull will stand. As regards time to blow ballast tanks, this is in favor of the single-hull type. Kingstons of single-hull boats can be made larger in proportion to tank volume, and construction offers less resistance to rapid flow of water in the tanks.

Sea-Keeping Qualities.

Double Hull.—Comparative tests between the two types under discussion, conducted by the French, showed the superiority of the double-hull type over the single-hull type in "necessary qualities for all prolonged navigation at sea."

With regard to "sea-keeping qualities," a service comparison of boats in our service (L class and M class) would be of value.

Armament.

Double Hull.—Superior in offensive qualities.

Single Hull.—Single-hull boats may have the same armament as double-hull boats of the same displacement.

Buoyancy.

Double Hull.—As double-hull types usually have about twice the reserve buoyancy of single-hull types, they are much safer. Reserve buoyancy is an essential requirement for sea-worthiness.

Single Hull.—Single hulls have less reserve buoyancy than double-hull boats. The outer hull

in way of ballast tank is, however, stronger in the single-hull design, and it is considered for this reason that this type of vessel is as safe as the double hull. The reserve buoyancy for single-hull designs is real, whereas the reserve buoyancy on certain double-hull vessels is partly theoretical.

Safety in Case of Collision.

Double Hull.—The outer tanks offer a protection in case of collision, as they are filled with sea water, and the shock does not come directly on the pressure body. This is true in case the collision happens in way of the double hull portion of the boat, and it is not of sufficient force to penetrate the inner shell. Since the outer hull is of comparatively light construction, its absolute value in this connection is open to question. The chances are that, if the outer hull is damaged, the inner hull will be injured also. The space between the inner and outer hulls is not filled with water when the vessel is on the surface, and collision happens generally on the surface.

If the outer tanks are filled with water or oil, this will transmit the pressure of an explosion to the strength hull, and the protection offered is more theoretical than real, but if the tanks are empty or only partially full, a genuine protection is offered against depth bombs, mines, etc. This is a matter of considerable importance in warfare as carried on today.

Submerged Resistance.

Double Hull.—These craft possess the possibility of greater submerged speed on account of the smaller resistance, due to the better form of hull. So far as authentic records go, these possibilities have not been realized.

Resistance curves of two boats, one a double-hull boat, the other a single-hull boat, made from experiments extending over a period of years, gave the following results:

			Surface
Double Hull..327 tons	1,400 I. H. P.	15.8 knots	
Single Hull..334 tons	1,400 I. H. P.	13.4 knots	
			Submerged
Double Hull..327 tons	480 I. H. P.	9 knots	
Single Hull..334 tons	480 I. H. P.	9.5 knots	

These tests were reported by Mr. G. Berling of Kiel.

Single Hull.—For boats of the same surface displacement, experience indicates that submerged resistance is in favor of the single hull design. The actual shape of model for submerged running makes comparatively little difference. The increased resistance of the double hull type is due to the increased submerged displacement, and consequently increased wetted surface.

Disadvantages of the Double-Hull Type.

(a) The hull tanks are of course weaker than the spindle hull, and it would be dangerous to pump tanks deeply submerged.

(b) A very large metacentric height is necessary in the light condition in order to obtain a safe metacentric height while submerging, and when submerged; otherwise the stability approaches zero when trimming down.

(c) A large metacentric height will probably give us a stiff boat whose surface activities in a seaway will resemble those of a destroyer. This may be relieved by bilge keels.

(d) In a double-hull type the effect of the free ballast water is more profound than in the single-hull type, because in the former the weight and moment of the ballast water are larger than in the latter.

Advantages of Single-Hull Type.

Simplicity of Construction.—The single-hull boat is undoubtedly much simpler to construct. The main ballast tanks occupy a shorter relative space in the boat and access in the tanks is much better for construction, cleaning and painting. The simpler construction makes it possible to build or repair the single-hull type in a much shorter time than a vessel of the double hull type.

Lighter Weight.—From actual experience it appears that hull weight of a single-hull boat for 200 feet submergence is the same as that of a double hull for 150 feet for same light displacement, and therefore a double hull for 200 feet depth will be heavier. Except for boats of high surface speed, the single-hull boat has thus a balance of weight in its favor which may be used for other purposes.

The single-hull boat, having less reserve buoyancy, will require less air for blowing tanks, so that a further weight is available for improving military qualities.

A single-hull boat will require less displacement to fulfil a given program of speed, radius, armament and depth test, in view of weight savings indicated herein.

Time to Fill Tanks.—In view of better access to ballast tanks the single-hull type will flood quicker than the double hull with same relative size of kingstons. This objection to the double hull might be overcome by further subdivision of the main ballast, and operating a part of the kingstons from stations forward and aft (probably at forward end of battery and after end of engine room). The tanks on single-hull boats are lower and therefore the mean hydrostatic head is greater while filling. This advantage can only be overcome on the double-hull boat by the use of larger kingstons.

The above arguments will no doubt be considered as confusing rather than as clarifying the situation, but, as indicated earlier in the paper, these are the arguments advanced and answers given by the advocates of the types under discussion. If the size of the boat is considered, there will come a dividing line beyond which the double-hull type has many important advantages over the single hull. The problem therefore reduces itself primarily into deciding where this dividing line is. There can be little question but that for boats up to 600 tons surface displacement, the advantages of single-hull predominate; from 600 tons to 800 tons there is little to choose from; beyond 700 tons it appears that the double-hull boat has the call and, when greater displacements than 800 tons are considered, the advantages of double-hull boats for work with the fleet greatly outweigh the advantages of the single-hull type.

The lines of the hull lend themselves much more readily to high surface speed requirements; in fact destroyer lines can be approximated; there is more deck room; there is greater freeboard; greater surface cruising radius is available; better gun platforms and working circles can be obtained; hull strength and depth test can readily be made to equal that of the single hull; greater safety is obtained, not only against serious damage or account of collision both surface and submerged but also against mines, depth bombs, and surface and submerged shell fire.

It may be of interest to note that comparative tests were made not very long ago in which three types of boats (one single hull and two double hull) were built at the same time and by the same country. Unofficial reports indicated that the results of these tests were very much in favor of the single hull. This was quite a surprise to many interested in the two types, as the inference was that the conclusions were generally applicable to submarine construction, but, when the facts are analyzed, it appears that the boats are all less than 400 tons displacement, so that the results of the tests are not at all surprising.

The question of stability in submarine design is one that is necessarily handled with great care, for the designer is working with inches where his brother ship designer works with feet. In the single-hull type we find a small surface G. M. and a considerably larger submerged G. M.; in double hulls, on the contrary, we find a large surface G. M. and a comparatively small submerged G. M. In trimming we are lucky if we find any G. M. at all in either type, especially after the boats have been in commission a few years and various changes and alterations made. These changes are always additive. It is a rare sight to see a recommendation to eliminate anything from these over-congested craft.

There is little to choose from in the two types when it comes to this question of stability, for in a double hull type one fights shy of too much metacentric height on the surface for fear of getting a "heavy roller," yet clings to a comparatively large surface G. M. in order to have even a very few inches while trimming and a few more when submerged.

In the single hull the designer is constantly fighting to obtain the necessary inches for his surface G. M. in order that he may not have a crank vessel and in order that he may have those "very few inches" while trimming.

With more recent types, where displacements are around the 800-ton mark, it is becoming increasingly difficult to equip a single-hull boat with the armament and equipment desired and yet retain the requisite surface stability.

Last year the Society was informed that the tendency of the U. S. Navy was to continue the policy of building small submarines of about 400 to 500 tons' surface displacement. It is apparent that this policy has been modified during the year and the 1918 program of submarines calls for nothing but the 800-ton type. This is believed to be a great step in advance. Moreover, it is a step that is amply justified by a study of building programs and war conditions abroad.

Foreign tendencies, according to the newspapers, appear to favor much greater displacements, and we hear of 2,000-ton and 5,000-ton submarines. Some of them are actually in existence, but is this a tendency of construction or an experimental move? Is it a fixed policy or a freak opportunity? Not being a prophet I cannot furnish the answer, but I venture the prediction that the great preponderance of submarine construction going on today in the navies of the world is in the vicinity of the 800-ton type—a type that I believe is the most useful, all-the-year-round type of submarine. What the future holds no man can tell, but I will venture one more prediction—before this war is over the submarine will be found to be the best antidote for the submarine.

Read by the author before the Society of Naval Architects and Marine Engineers at the twenty-fifth annual meeting and published in Bulletin No. 9 of the Society.

BRITISH FINANCIERS INTERESTED IN MOTORSHIPS.

Five Million Dollars Subscribed in Three Days.

When the Flower Motorship Company was formed in England for the purpose of building three big Diesel driven vessels a capital of five million dollars ($5,000,000.00) was subscribed in three days by 200 stockholders. Among the important financiers that purchased stock were the following:

Name—	No. of Shares
Sir Marcus Samuel	100,000
Messrs. Rothschilds	50,000
Grahams & Co.	50,000
Mr. Samuel Samuel, M. P.	100,000
Central Mining & Investment Corporation	40,000
Sir Ernest Cassel	25,000
London County & Westminster Bank	25,000
Chaplin, Milne, Grenfell & Co., Ltd.	25,000
Kleinwert, Sons & Co.	20,000
Consolidated Gold Fields of S. Africa, Ltd.	20,000
Nobel Bros.	18,000
Neumann, Lubeck & Co.	10,000
Harris & Dixon, Ltd.	15,000
Balfour, Williamson & Co.	10,000
Mr. C. N. Hanson	10,000
Sir Geo. Barham	5,000
Mr. Frederick Lane	10,000

These names represent many of the most important financial and shipping houses in London.

THUS SPAKE A BRITISH STEAMSHIP OWNER!

Speaking before many important British financial and steamship men recently, Mr. Frederick Lane, (of Lane & Macandrew, the well-known London steamship owners) said: "On the termination of the war development in the marine oil-engine will proceed by leaps and bounds."

THE COVER FOR THIS NUMBER OF MOTORSHIP.

The motor auxiliary "Mount Rainier," an excellent reproduction of which forms this month's cover, is a sister ship to the motor auxiliaries "Santino" and "Grays Harbor." Like these vessels, she is equipped with twin 350 b. h. p. Sumner oil engines. She is the third vessel built for Atlantic trade for Gaston, Williams and Wigmore of New York and is 290 feet long, has a beam of 48 feet, with a capacity for 2,200,000 feet of lumber.